APPENDIX F

F. National Vegetation Classification Standard (NVCS) Local Descriptions for Sunset Crater Volcano National Monument

(Kathryn Thomas and Monica Hansen of the USGS Colorado Plateau Research Station collected, analyzed, and initially classified field relevé data. Marion Reid and Keith Schulz of NatureServe reviewed and finalized local classification and compiled global classification.)

The following vegetation descriptions are derived from the 114 vegetation relevés sampled throughout the course of this project. Global information, information based on reports throughout the distribution of the associations/alliances, was also compiled by NatureServe to augment the local descriptions. All of the vegetation association descriptions will include information on both the global and local descriptions, unless the associations have only been described from Sunset Crater Volcano National Monument.

The vegetation descriptions are separated into twelve sections. Many of the sections are subdivided into a 'Sunset Crater Volcano National Monument' and a 'Globally' section. After the Sunset Crater Volcano National Monument subheading information follows on the association/alliance as it appears in the park, the local information. After the Globally subheading information follows on the association/alliance as it appears throughout its range. Information about each of the sections is described in Table 1.

Table 1. Explanations on the vegetation descriptions sections.

Vegetation Description Sections	Explanation
Classification Confidence Level	The classification confidence level identified by NatureServe.
USFS Wetland System	The U.S. Department of Agriculture – Forest Service wetland classification system ranking crosswalked to NVCS associations, provided by NatureServe.
Range	The range describes where this association was mapped in the project area, information on where particular relevés were sampled, and where the association occurs throughout its entire range.
Environmental Description	Environmental description describes the abiotic conditions measured related to the association/alliance. In the local descriptions, all slopes are described as a range of elevation (lowest to highest elevation) as well as an average elevation across all of the relevés measured in meters (m).
Most Abundant Species	This section identifies the dominant and/or indicator species for Sunset Crater Volcano National Monument and globally throughout its range.
Associated Species	Associated species describes the most common species associated with all of the relevés locally and globally.
Vegetation Description	This section identifies the vegetation characteristics specific to the association/alliance. Locally, total vegetation cover is described as absolute percent cover and is given as a range (lowest to highest % cover) and average across all of the relevés. Diameter Base Height (DBH) is provided in centimeters (cm) if trees were present in the relevés.

Conservation Rank	The conservation rank is a ranking system used to identify and prioritize conservation areas applied to NVCS associations by NatureServe. The global conservation rank is described in Table 2.
Database Code	Database codes are a unique code that NatureServe developed to organize and identify the vegetation associations.
Map Classes	Map classes describes how the association is crosswalked to the map class, a general description of where the map class occurs, and the total number of hectares and polygons occurring inside and outside Sunset Crater Volcano National Monument.
Comments	Comments particular to the vegetation description locally at Sunset Crater Volcano National Monument and globally.
References	References identified in the vegetation description.

Table 2. Conservation ranking system for associations.

Global Conservation Rank	**% of Associations**
GX – Eliminated	0
GH – Presumed eliminated (historic)	<1
G1 – Critically imperiled	10
G2 – Imperiled	18
G3 – Vulnerable	22
G4 – Apparently secure	16
G5 – Secure	8
GU – Unrankable	3
G? – Unranked	22

List of vegetation community types (NVCS Associations) organized by NVCS structure.

Pinus edulis / Sparse Understory Forest

COMMON NAME	Two-needle Pinyon / Sparse Understory Forest
PHYSIOGNOMIC CLASS	Forest (I.)
PHYSIOGNOMIC SUBCLASS	Evergreen forest (I.A.)
PHYSIOGNOMIC GROUP	Temperate or subpolar needle-leaved evergreen forest (I.A.8)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural Temperate or subpolar needle-leaved evergreen forest (I.A.8.N)
FORMATION	Rounded-crown temperate or subpolar needle-leaved evergreen forest (I.A.8.N.b)
ALLIANCE	*Pinus edulis* Forest Alliance

CLASSIFICATION CONFIDENCE LEVEL Strong

USFS WETLAND SYSTEM Upland

RANGE

Sunset Crater Volcano National Monument

Two-needle Pinyon / Sparse Understory Forest occurs on cinder cones in the park environs adjacent to the Sunset Crater Volcano NM boundaries. Within the environs of the project study boundary this vegetation type was mapped within the San Francisco volcanic field on the northern and eastern slopes of various unnamed cinder cones and also on Black Mountain. Only one representative stand was sampled in our study, on the northeastern slope of O'Leary peak.

Globally

These woodlands are found locally on the Colorado Plateau, but likely are more widespread and occur throughout the range of *Pinus edulis.*

ENVIRONMENTAL DESCRIPTION

Sunset Crater Volcano National Monument

This association occurs mostly on the steep cooler slopes of the northern and eastern cinder cones. The one representative stand had 55% slope, an elevation of 2,200m, and occurred on fine cinder soils.

Globally

These forests and woodlands occur in foothills, mesas, plateaus and mountains of New Mexico, Ariziona and Utah. Sites are flat to moderately sloping at elevations that range from 1,980-2,290 m (6,500-7,500 feet). Stands frequently occur on less xeric, northern and eastern exposures, but it can occur on all aspects. Substrates are variable but often include eroded, shallow or coarse-textured substrates such as cinder (but not rock outcrops) that limit the growth of understory shrubs and herbaceous plants. Cover of tree litter is dense in some stands (Kennedy 1983). The original concept of this association included stands on relatively mesic sites with high tree growth potential that produced a dense tree canopy, which shades out the understory vegetation. However, the association also includes fire-suppressed stands and woodlands growing on eroded or "badlands" substrates and/or over-grazed stands that lack understory vegetation (Baker et al. 1995, Stuever and Hayden 1997a and b).

MOST ABUNDANT SPECIES

Sunset Crater Volcano National Monument

Stratum	Species
Tree canopy	*Pinus edulis*

Globally

Stratum	Species
Tree canopy	*Pinus edulis, Juniperus monosperma, Juniperus osteosperma*

ASSOCIATED SPECIES
Sunset Crater Volcano National Monument
Ageratina herbacea, Fallugia paradoxa

Globally
Juniperus scopulorum, Juniperus deppeana, Ageratina herbacea, Cercocarpus montanus, Fallugia paradoxa, Rhus trilobata, Gutierrezia sarothrae, Achnatherum hymenoides

VEGETATION DESCRIPTION
Sunset Crater Volcano National Monument
Only one relevé was classified as *Pinus edulis* sparse understory forest, where the total vegetation cover is 70% with 63% within the tree layer, 6% within the shrub layer, and 11% within the herbaceous layer.

Within the one relevé, mature *Pinus edulis* had a cover of 62%. The DBH ranged from 17-50cm (average 32cm).

Twenty-one species of shrubs and herbs were measured within this association. The most common shrubs were *Ageratina herbacea* and *Fallugia paradoxa*, both with less than 4% of the total cover.

Globally
This plant association is characterized by a moderate (over 25% cover) to dense tree canopy with little or no understory. The tree canopy is dominated by *Pinus edulis*. Other trees may co-dominate especially one or more species of *Juniperus* that vary with geography, such as *J. monosperma, J. osteosperma, J. scopulorum* or *J. deppeana*. If other species of *Pinus* are present they do not co-dominate. The sparse understory (<10% cover and usually <2%) may include scattered shrubs, dwarf-shrubs, succulents, grasses and forbs such as *Ageratina herbacea, Cercocarpus montanus, Fallugia paradoxa, Rhus trilobata, Gutierrezia sarothrae, Achnatherum hymenoides* and species of *Opuntia, Yucca, Poa, Penstemon,* and *Phlox.*

CONSERVATION RANK G5

DATABASE CODE CEGL000795

MAP CLASSES
Two-needle Pinyon / Sparse Understory Forest is mapped as part of the Pinyon Pine – Utah Juniper / Blue Grama Woodland map class which corresponds to map codes 11 and 12

The map class Pinyon Pine - Utah Juniper / Blue Grama Woodland occurs mainly on the northern and eastern section of the project boundary. The total area mapped within Sunset Crater Volcano NM is 2 hectares within 5 polygons and the total area in the park environs is 394 hectares within 59 polygons.

COMMENTS
Sunset Crater Volcano National Monument
The Pinyon / Sparse Understory Forest is distinct with a high canopy cover of Pinyon, absence of Utah Juniper, and a sparse understory. This types grades into the Pinyon (Juniper) / Blue Grama Woodland association at lower elevations with less steep slopes; however, due to difficulty in photointerpretation, the two associations have been combined into one map class: Pinyon Pine – Utah Juniper / Blue Grama Woodland.

Global Comments
The original concept of this plant association had a nearly closed tree canopy with a sparse, shaded understory growing on relatively mesic sites. These forests may actually be a product of fire suppression, livestock grazing removal of fine fuels, and/or soil erosion, and may be present in degraded examples of other *Pinus edulis* associations (Stuever and Hayden 1997a and b). The association concept has been expanded to include more open-growing stands by Muldavin et al. (2000) who included stands under 20% tree cover

Global Dynamics

Pinus edulis is extremely drought-tolerant and slow-growing (Little 1987, Powell 1988, Muldavin et al. 1998a). It is also non-sprouting and may be killed by fire. However, fire frequency is relatively low because of the lack of continuous fine fuel needed to spread ground fire. When fire occurs, it will likely be severe, occurring under the extreme conditions (high winds) needed to carry a crown fire (Bradley et al. 1992, Wright et al. 1979). Active fire suppression and historic grazing by livestock (which has removed the fine fuels that carry fire) have likely altered natural fire regimes and may have contributed to the conversion of open woodlands to closed tree canopies with sparse understories. Subsequent erosion of bare soil can be expected to reduce site productivity (Baker et al. 1995).

REFERENCES

Baker et al. 1995, Bradley et al. 1992, Kennedy 1983, Muldavin et al. 2000, Stuever and Hayden 1997a and b, Wright et al. 1979

Pseudotsuga menziesii Forest Alliance

COMMON NAME	Douglas-fir Forest Alliance
PHYSIOGNOMIC CLASS	Forest (I.)
PHYSIOGNOMIC SUBCLASS	Evergreen forest (I.A.)
PHYSIOGNOMIC GROUP	Temperate or subpolar needle-leaved evergreen forest (I.A.8)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural (I.A.8.N)
FORMATION	Conical-crowned temperate or subpolar needle-leaved evergreen forest (I.A.8.N.c)
ALLIANCE	*Pseudotsuga menziesii* Forest Alliance

CLASSIFICATION CONFIDENCE LEVEL Alliances are not ranked by NatureServe for classification confidence

USFS WETLAND SYSTEM Upland

RANGE

Sunset Crater Volcano National Monument

Douglas-fir Forest is mapped on the cooler northern slopes of O'Leary Peak and on the top of Darton Dome. Only one relevé was sampled and it occurred in a cold air-drainage on the western slope of O'Leary Peak.

Globally

This montane and coastal alliance includes evergreen forests dominated by *Pseudotsuga menziesii* occurring from Vancouver Island south through the Cascades and coastal ranges of northern California, through the Rocky Mountains, the Nevada-Utah mountains, the Arizona-New Mexico mountains, to extreme western Texas and northern Mexico.

ENVIRONMENTAL DESCRIPTION

Sunset Crater Volcano National Monument

Douglas-fir Forest was sampled at an elevation of 2,600m on a steep slope (40%).

Globally

Forest associations within this alliance occur in two major distributions. The first is along the northwest Pacific slope in low-elevation valleys of western Oregon and Washington, in scattered dry sites of the Olympics and western Cascades, and along the eastern slope of the Oregon and Washington Cascades. The second is in the Rocky Mountains, extending from the Okanogan Highlands and Blue Mountains of eastern Washington and Oregon south and east into the mountains of the Great Basin and into the Rocky Mountains from Montana south into northern Mexico.

The Pacific Northwest region has mild winter temperatures, cool to hot summers, and receives 75-250 cm of annual precipitation in a Mediterranean pattern of winter rain followed by summer drought. The majority of the precipitation falls as rain, but snowfall can be abundant at montane elevations. These forests occur along low- to moderate-elevation (0-1300 m) mountain slopes and valley margins, with an increasing affinity for moist topographic positions away from the coast and southward. They occupy sites where soil drought is induced by site features (shallow soils, sunny aspect) or local rainshadow effects that lessen precipitation. Generally these forests are in drier sites or zones than *Pseudotsuga menziesii - Abies grandis* forests but more moist sites or zones than *Pinus ponderosa - Pseudotsuga menziesii* woodlands. Contiguous vegetation is often *Quercus* spp. woodlands and savannas, chaparral, or annual grasslands at the xeric margin, and closed *Sequoia sempervirens* or *Tsuga heterophylla* forests at the mesic margin.

Pseudotsuga menziesii forests found in the Rocky Mountains occur under a comparatively drier and more continental climate regime, and at higher elevations than in the Pacific Northwest. Elevations range from less than 1000 m in the northern Rocky Mountains to nearly 2900 m in the southern Rockies and plateaus of the southwestern U.S. Lower elevation stands typically occupy protected northern exposures or mesic ravines and canyons, often on steep slopes. At higher elevations, these forests occur primarily on southerly aspects or ridgetops. Precipitation ranges from 50-100 cm with moderate snowfall and with a greater proportion falling during the growing season.

Monsoonal summer rains can contribute a significant proportion of the annual precipitation in Arizona, New Mexico, and Colorado. Adjacent vegetation is typically dominated by *Pinus ponderosa* or *Pinus flexilis* (in Idaho and Montana) on drier, warmer sites; *Picea* spp. on more moist sites; *Abies concolor* (in New Mexico and Arizona) or *Abies lasiocarpa* at higher, cooler sites. Montane grasslands and meadows may also occur in patches within these forests, or on adjacent dry slopes.

Soils are highly variable across the range of this alliance and derived from diverse parent materials. *Pseudotsuga menziesii* forests are reported by most studies (Lillybridge et al. 1995, Steele et al. 1981, Pfister et al. 1977, Mauk and Henderson 1984) to show no particular affinities to geologic substrates. Rock types can include marine sediments in northern California and Oregon, glacial deposits in the Puget Sound, extrusive volcanics in the Cascades and Columbia Basin, and sedimentary rocks in the central and southern Rockies and the Colorado Plateau. The soils are typically slightly acidic (pH 5.0-6.0), well-drained, and well-aerated. They can be derived from moderately deep colluvium or shallow jointed bedrock, and are usually gravelly or rocky.

MOST ABUNDANT SPECIES

Sunset Crater Volcano National Monument

Stratum	Species
Tree canopy	*Pseudotsuga menziesii, Pinus flexilis*

Globally

Stratum	Species
Tree canopy	*Pseudotsuga menziesii, Pinus ponderosa*

ASSOCIATED SPECIES

Sunset Crater Volcano National Monument

Ribes cereum, Holodiscus dumosus

Globally

Arbutus menziesii, Acer circinatum, Acer glabrum, Acer grandidentatum, Amelanchier alnifolia, Quercus arizonica, Quercus gambelii, Quercus hypoleucoides, Quercus rugosa, Arctostaphylos patula, Arctostaphylos uva-ursi, Arnica cordifolia, Bromus ciliatus, Calamagrostis rubescens, Carex geyeri, Festuca arizonica, Festuca occidentalis, Gaultheria shallon, Holodiscus discolor, Jamesia americana, Juniperus communis, Juniperus osteosperma, Linnaea borealis, Mahonia repens, Muhlenbergia montana, Muhlenbergia virescens, Osmorhiza berteroi, Paxistima myrsinites, Physocarpus malvaceus, Purshia tridentata, Spiraea betulifolia, Symphoricarpos albus, Symphoricarpos occidentalis, Symphoricarpos oreophilus, Thalictrum occidentale, Vaccinium caespitosum, Vaccinium membranaceum, Viola adunca

VEGETATION DESCRIPTION

Sunset Crater Volcano National Monument

Only one relevé was sampled within the Douglas-fir Forest alliance. The total vegetation cover was 70% with 65% in the tree layer, 4% in the shrub layer, and 1% in the herbaceous layer. Fifteen species were found on the relevé, most with low cover.

Tree canopy was co-dominated by *Pseudotsuga menziesii* (35%) and *Pinus flexilis* (30%). *Pseudotsuga menziesii* DBH ranged from 12-65 cm (average 35 cm) and *Pinus flexilis* ranged from 11.5-31 cm (average 16.2 cm). Fifty to sixty-five percent of the trees in the relevé were 10-30 meters tall, with the remainder 10 meters or shorter.

The shrub layer was characterized by *Ribes cereum* and *Holodiscus dumosus*. The herbaceous layer was nearly absent (~1% total cover).

Globally

This alliance includes evergreen forests dominated by *Pseudotsuga menziesii* occurring in mountain ranges of western U.S., as well as northern Mexico, and western Texas. In the Pacific ranges the dominant species is *Pseudotsuga menziesii* var. *menziesii*, while *Pseudotsuga menziesii* var. *glauca* is the dominant in forests of the Rocky Mountains, south to Mexico.

On the eastside of the Cascades and east into the northern and southern Rocky Mountains, these forests are dominated by *Pseudotsuga menziesii* in the canopy and almost always in the tree regeneration layer. *Pinus ponderosa* is an important seral species occurring in many associations, either as older seral remnants or codominating in the canopy. Other trees that can be present to abundant (but which are typically seral) include *Larix occidentalis* in the northern Rockies, *Populus tremuloides*, (in the southern Rockies and south into New Mexico and Arizona), *Pinus strobiformis* or *P. flexilis* (in New Mexico and Arizona), and *Pinus contorta* (throughout much of the alliance's range). Species of *Abies* and *Picea* do not commonly occur in this alliance, but are present in some stands.

Understories in *Pseudotsuga menziesii* forests are varied; many associations have well-developed shrub layers, varying in height from <2 m (typically), up to 5 m. Dominant species in some associations in the northern Rockies include *Acer glabrum, Linnaea borealis, Paxistima myrsinites, Physocarpus malvaceus, Symphoricarpos albus, Symphoricarpos oreophilus, Spiraea betulifolia, Vaccinium caespitosum*, and *Vaccinium membranaceum*. Further south other shrubs become the dominant or diagnostic species, such as *Acer grandidentatum, Amelanchier alnifolia, Arctostaphylos patula, Jamesia americana, Physocarpus monogynus, Quercus arizonica, Quercus gambelii, Quercus rugosa, Quercus X pauciloba*, and *Quercus hypoleucoides. Arctostaphylos uva-ursi* and *Mahonia repens* are present to important throughout the range.

The herbaceous layer can be sparse, or if the shrub layer is not abundant, can be relatively species-rich, usually graminoid-dominated. Important or dominant species include the graminoids *Bromus ciliatus, Calamagrostis rubescens, Carex geyeri, Carex rossii, Festuca arizonica, Festuca occidentalis, Bromus ciliatus, Luzula parviflora, Muhlenbergia montana*, and *Muhlenbergia virescens* and the forbs *Arnica cordifolia, Osmorhiza berteroi, Thalictrum occidentale, Viola adunca*, and species of many other genera, including *Lathyrus, Penstemon, Erigeron, Lupinus, Fragaria, Vicia, Arenaria, Galium*, and others.

In the low elevation forests of western Washington and Oregon (west of the Cascade crest) the canopy is semi-open to closed. *Pseudotsuga menziesii* dominates with little or no *Tsuga heterophylla* or *Thuja plicata*. *Abies grandis* is codominant on some sites, and *Pinus contorta* can also codominate. *Salix scouleriana* and *Arbutus menziesii* are common but subordinate. There is a well-developed understory of deciduous or evergreen shrubs, or graminoids. *Holodiscus discolor, Symphoricarpos albus*, or *Rosa gymnocarpa* are typical dominant species and diagnostic. Other shrubs that may be important include *Gaultheria shallon, Rhododendron macrophyllum, Vaccinium ovatum, Mahonia aquifolium (= Mahonia piperiana), Mahonia nervosa, Corylus cornuta*, and *Symphoricarpos mollis*. In the herbaceus layer *Festuca occidentalis*, and *Melica subulata* are diagnostic species which are often dominant or codominant. *Bromus vulgaris, Festuca subuliflora*, and *Elymus glaucus* are also very common.

DATABASE CODE A.157

MAP CLASSES
Pseudotsuga menziesii Forest Alliance is mapped as map class Douglas-fir Forest, map code 21. The map class Douglas-fir Forest includes both the *Pseudotsuga menziesii* Forest Alliance and *Pseudotsuga menziesii / Muhlenbergia montana* Forest association.

The map class Douglas-fir Forest occurs only at high elevation on Darton Dome and O'Leary Peak, mostly with eastern or northern aspects. Douglas-fir Forest does not occur in Sunset Crater Volcano NM and only occurs in the park environs; the total area mapped in the park environs is 29 hectares within 7 polygons.

COMMENTS
Sunset Crater Volcano National Monument
This relevé did not represent any previously described associations within the Douglas-fir Forest alliance. Therefore, it was placed at the courser level of classification in the Douglas-fir Forest alliance. The vegetation assemblage may represent a new association, but such designation will require additional relevé data from other locations.

Global Comments
This alliance is derived from a series concept, where the presence of *Pseudotsuga menziesii* is diagnostic if other more shade-tolerant conifers are absent (presumes dominance of *Pseudotsuga menziesii* if some form of disturbance or extreme edaphic conditions do not limit its regeneration). In the Pacific ranges, the dominant taxon is *Pseudotsuga menziesii* var. *menziesii*, while *Pseudotsuga menziesii* var. *glauca* is the dominant in forests of the Rocky Mountains south into Mexico.

Global Dynamics
Successional relationships in this alliance are complex. *Pseudotsuga menziesii* is less shade-tolerant than many northern or montane trees such as *Tsuga heterophylla, Abies concolor, Picea engelmannii*, or *Thuja plicata*, and seedlings compete poorly in deep shade. At drier locales, seedlings may be favored by moderate shading, such as by a canopy of *Pinus ponderosa*, which helps to minimize drought stress. In some locations, much of these forests have been logged or burned during European settlement, and present-day stands are second-growth forests dating from fire, logging, or other stand replacing disturbances (Mauk and Henderson 1984, Chappell et al. 1997). *Pseudotsuga menziesii* forests were probably subject to a moderate severity fire regime in pre-settlement times, with fire-return intervals of 30-100 years. Many of the important tree species in these forests are fire-adapted (*Populus tremuloides, Pinus ponderosa, Pinus contorta, Larix occidentalis*) (Pfister et al. 1977), and fire-induced reproduction of *Pinus ponderosa* can result in its continued codominance in *Pseudotsuga menziesii* forests (Steele et al. 1981). Seeds of the shrub *Ceanothus velutinus* can remain dormant in forest stands for 200 years (Steele et al. 1981) and germinate abundantly after fire, competitively suppressing conifer seedlings. Some stands may have higher tree-stem density now than historically, due largely to fire suppression. Fire suppression has also lead to the succession of *Pinus ponderosa* woodlands or *Quercus* spp. woodlands to *Pseudotsuga menziesii* forests.

REFERENCES
Chappell et al. 1997, Lillybridge et al. 1995, Mauk and Henderson 1984, Pfister et al. 1977, Steele et al. 1981

Pseudotsuga menziesii / Muhlenbergia montana Forest

COMMON NAME	Douglas-fir / Mountain Muhly Forest
PHYSIOGNOMIC CLASS	Forest (I.)
PHYSIOGNOMIC SUBCLASS	Evergreen forest (I.A.)
PHYSIOGNOMIC GROUP	Temperate or subpolar needle-leaved evergreen forest (I.A.8)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural (I.A.8.N)
FORMATION	Conical-crowned temperate or subpolar needle-leaved evergreen forest (I.A.8.N.c)
ALLIANCE	*Pseudotsuga menziesii* Forest Alliance

CLASSIFICATION CONFIDENCE LEVEL Strong

USFS WETLAND SYSTEM Upland

RANGE

Sunset Crater Volcano National Monument

The Douglas-fir / Mountain Muhly Forest occurs on higher elevation cinder cones in the project environs. Only one relevé was sampled, at the top of Darton Dome.

Globally

This forest association occurs on mountains and plateaus in Trans-Pecos Texas, New Mexico, Arizona, and possibly Colorado.

ENVIRONMENTAL DESCRIPTION

Sunset Crater Volcano National Monument

This association occurs on the northern and eastern slopes of cinder cones in cinder gravel within the project environs at high elevations. The one relevé sampled occurred at an elevation of 2,250m and in a flat location (~8% slope).

Globally

This forested plant association occurs on mountains and plateaus in Trans-Pecos Texas, New Mexico, Arizona, and possibly Colorado. Sites are variable and include rocky ridge tops, gentle to steep slopes, stream sides and cinder cones. Elevation ranges from 2,650–2,970 m (8,700-9,750 feet) on steep south and west facing slopes, and down to 2245 m (7500 feet) on cool, northerly slopes. Substrates are generally dry, shallow, well-drained, gravelly or cobbly, coarse-textured soils. Lower elevation soils may be deep sands or cinder.

MOST ABUNDANT SPECIES

Sunset Crater Volcano National Monument

Stratum	Species
Tree canopy	*Pseudotsuga menziesii, Pinus ponderosa*
Herbaceous	*Muhlenbergia montana*

Globally

Stratum	Species
Tree canopy	*Pseudotsuga menziesii, Pinus ponderosa*
Herbaceous	*Muhlenbergia montana*

ASSOCIATED SPECIES

Sunset Crater Volcano National Monument

Oxytropis lambertii

Globally

Pinus ponderosa, Pinus strobiformis, Pinus flexilis, Pinus edulis, Juniperus deppeana, Juniperus scopulorum, Ceanothus fendleri, Cercocarpus montanus, Holodiscus dumosus, Mahonia repens, Quercus grisea, Ribes cereum

VEGETATION DESCRIPTION

Sunset Crater Volcano National Monument

In the one relevé of Douglas-fir / Mountain Muhly Forest sampled total vegetation cover was 50%, with 45% relative cover in the tree layer, 1% in the shrub layer, and 13% in the ground layer. Ten species were recorded.

Pseudotsuga menziesii and *Pinus ponderosa* were the dominant trees with *Pseudotsuga menziesii* having 25% cover and *Pinus ponderosa* with 20% cover. The DBH for *Pseudotsuga menziesii* ranged from 11-95cm (average 23cm) and the DBH for *Pinus ponderosa,* mostly young trees, ranged from 11.5-21.5cm (average14.5). Tree heights ranged from 3-20 m.

The shrub layer was virtually absent (<0.5%). The herbaceous layer was characterized by *Muhlenbergia montana* (12% cover).

Globally

This plant association is characterized by a moderately dense evergreen tree canopy dominated or co-dominated by *Pseudotsuga menziesii* with a *Muhlenbergia montana* dominated graminoid layer. Other tree species may include large *Pinus ponderosa* (often co-dominant), and scattered *Pinus flexilis* (northern stands), *Pinus strobiformis, Pinus edulis, Juniperus deppeana* or, *J. scopulorum* (especially on dryer sites and southern stands). *Abies concolor* is not present or accidental. *Quercus gambelii* may be present in the subcanopy (tree form) or tall-shrub layer, but with less than 5% cover. Shrub cover is typically sparse (< 10% cover) and consists of scattered *Ceanothus fendleri, Cercocarpus montanus, Holodiscus dumosus, Mahonia repens, Quercus grisea* or *Ribes cereum.* The herbaceous layer is dominated by graminoids and is moderately dense and diverse. *Muhlenbergia montana* is the most consistent graminoid species and typically dominates. Other graminoids include *Blepharoneuron tricholepis, Bromus* spp., *Carex rossii, Elymus elymoides, Koeleria macrantha,* and *Poa fendleriana* but not *Festuca arizonica* or *Muhlenbergia virescens*. The forb cover is sparse. Common species are *Artemisia ludoviciana, Geranium caespitosum, Lithosperma multiflorum, Packera neomexicana, Pseudocymopteris montanus,* and *Thalictrum fendleri* (Alexander et al. 1987, Fitzhugh et al. 1987, Muldavin et al. 1996, Stuever and Hayden 1997a or b). The graminoid layer has greater than or equal shrub cover.

CONSERVATION RANK G4

DATABASE CODE CEGL000443

MAP CLASSES

Douglas-fir / Mountain Muhly Forest association was mapped as map class Douglas-fir Forest corresponding to map code 21. The map class Douglas-fir Forest includes both the *Pseudotsuga menziesii* Forest Alliance and *Pseudotsuga menziesii / Muhlenbergia montana* Forest association.

This map class only occurs within the environs of the study boundary and does not occur within Sunset Crater Volcano NM. Map class Douglas-fir Forest occurs on the northern side of Darton Dome and along the southeastern side of O'Leary Peak. The total hectares mapped are 29 and these occur within 7 polygons.

COMMENTS

Sunset Crater Volcano National Monument

The Douglas-fir / Mountain Muhly Forest association differs from the global description due to having <60% tree cover and with *Pinus ponderosa* co-dominating the association. This association needs to be further sampled within the Colorado Plateau to determine if this relevé would be better classified as a woodland rather than a forest type. Due to this type occurring in the environs of the project boundary, additional relevés were not sampled within this project boundary.

Global Comments

Two phases of this association are described by Stuever and Hayden (1997a or b). The limber pine (*Pinus flexilis*) phase is described from higher elevation stands in northern New Mexico (Muldavin et al. 1996) and the two-needle pinyon (*Pinus edulis*) phase from more southern latitudes where *Pinus edulis, P. strobiformis, Juniperus deppeana,* and *J. scopulorum* are common seral species (Stuever and Hayden 1997a or b).

Global Dynamics

Both diagnostic species are tolerant of ground fire. *Pseudotsuga menziesii* develops thick fire-resistant bark with age, and *Muhlenbergia montana* resprouts after burning although it may take a few years to recover to pre-burn density (Fischer and Bradley 1987, Wright et al. 1979). Fire-return interval can be low in areas in dry, rocky stands where ground fire is limited by lack of continuous fine fuels. The sparse shrub layer reduces the risk of crown fire by limited ladder fuel to the crown of overstory trees. If fire frequency is high, the more fire-resistant tree *Pinus ponderosa* will be favored and may become dominant (Stuever and Hayden 1997b). Disturbance of tree canopy favors graminoids (Alexander et al. 1987). Improper livestock grazing (where accessible) can result in converting the herbaceous layer from graminoids to unpalatable forbs (Fitzhugh et al. 1987). Dryer sites tend to have more graminoids and more mesic stands have more shrubs (Alexander et al. 1987).

REFERENCES

Alexander et al. 1987, Fischer and Bradley 1987, Fitzhugh et al. 1987, Muldavin et al. 1996, Stuever and Hayden 1997b, Wright et al. 1979

Pinus edulis – (Juniperus osteosperma) / Bouteloua gracilis Woodland

COMMON NAME	Two-needle Pinyon – (Utah Juniper) / Blue Grama Woodland
PHYSIOGNOMIC CLASS	Woodland (II.)
PHYSIOGNOMIC SUBCLASS	Evergreen woodland (II.A.)
PHYSIOGNOMIC GROUP	Temperate or subpolar needle-leaved evergreen woodland (II.A.4.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural (II.A.4.N.)
FORMATION	Rounded-crowned temperate or subpolar needle-leaved evergreen woodland (II.A.4.N.a.)
ALLIANCE	*Pinus edulis – (Juniperus* spp.*)* Woodland Alliance

CLASSIFICATION CONFIDENCE LEVEL Moderate

USFS WETLAND SYSTEM Upland

RANGE

Sunset Crater Volcano National Monument

Two-needle Pinyon - Utah Juniper / Blue Grama Woodland occurs within Sunset Crater Volcano NM on the eastern side of Sunset Crater. This association is also common within the environs at the bases of cinder cones. This association is found on Black Mountain, Darton Dome, O' Leary Peak, Robinson Mountain, and Robinson Crater in the study environs.

Globally

This woodland association occurs in the cinder fields, mountains and mesas in the southern Colorado Plateau and Mogollon Rim, and may extend into southern Utah and western Colorado.

ENVIRONMENTAL DESCRIPTION

Sunset Crater Volcano National Monument

This association occurs at 2,100-2,300m. It occurs at the base of cinder cones and in flat lower elevation areas. It is frequently on the southern exposure of cinder cones and occasionally climbs towards the top of the cinder cones. Slope ranges from 10-40%. The typical substrate consists of cinder gravel with a smaller percentage of cinder sand and lava cobbles.

Globally

This woodland association is known from the mountains and mesas in the southern Colorado Plateau, Mogollon Rim and extends into southern Utah and western Colorado. Elevations normally range from 2,100-2,300m (6,885-7,540 feet). Sites are variable, but generally are relatively dry and rocky. Stands occur on flat to moderate slopes along drainages and on mesa tops, on gentle to moderate 10-40% rocky slopes of foothills, and at the base of cinder cones. The substrates are variable and range from deep, coarse textured soil derived from cinder, to sandy loams derived from sandstone or fine-textured soils derived from limestone.

MOST ABUNDANT SPECIES

Sunset Crater Volcano National Monument

Stratum	Species
Tree canopy	*Pinus edulis, Juniperus osteosperma, Juniperus deppeana*
Herbaceous	*Bouteloua gracilis*

Globally

Stratum	Species
Tree canopy	*Pinus edulis, Juniperus osteosperma, Juniperus deppeana, Juniperus scopulorum*
Herbaceous	*Bouteloua gracilis*

ASSOCIATED SPECIES

Sunset Crater Volcano National Monument

Ageratina herbacea, Aristida divaricata, Artemisia carruthii, Artemisia dracunculus, Bouteloua curtipendula, Brickellia californica, Cercocarpus montanus, Ericameria nauseosa, Eriogonum corymbosum, Fallugia paradoxa, Ipomopsis aggregata, Oxytropis lambertii, Mahonia fremontii, Purshia stansburiana, Ribes cereum, Rhus trilobata, Yucca baccata, Verbascum thapsus

Globally

Juniperus deppeana, Juniperus scopulorum, Cercocarpus montanus, Ericameria nauseosa, Rhus trilobata, Yucca spp., *Achnatherum hymenoides, Bouteloua curtipendula, Elymus elymoides, Koeleria macrantha, Hesperostipa comata, Hesperostipa neomexicana, Pleuraphis jamesii*

VEGETATION DESCRIPTION

Sunset Crater Volcano National Monument

Two-needle Pinyon - Utah Juniper / Blue Grama Woodland was sampled in seven relevés with a total vegetation cover ranging from 23-62% (average 42%). Absolute cover in the tree layer ranges from 20-55% (average 30%), in the shrub layer 2-10% (average 5%), and in the herbaceous layer 2-20% (average 5%). The total number of species ranged from 12-29 species (average 21).

Within the tree layer *Pinus edulis* ranged from 11-54% absolute cover (average 19%) and *Juniperus osteosperma* 2-26% (average 9%). *Juniperus deppeana* occurred in 43% of the total relevés with 6-16.5% absolute cover (average 11%). *Pinus edulis* DBH ranged from 11-92cm (average 29cm), *Juniperus osteosperma* 11.5-59.5cm (average 26cm), and *Juniperus deppeana* 10.5-75cm (average 32cm). One to five percent of all trees within this association had a height of 3-5 m, 5-10% were 5-10 m, and less than 1% were 10-20m tall.

The shrub layer had 2-10% absolute cover with the dominant shrubs consisting of *Fallugia paradoxa* and *Rhus trilobata*. The herbaceous layer had 2-20% absolute cover with the characteristic species being *Bouteloua gracilis* and *Artemisia dracunculus.*

Globally

This plant association is characterized by an open to moderately dense tree canopy (10-65% cover) co-dominated by *Pinus edulis* and *Juniperus osteosperma*. *Pinus edulis* may be present with relatively small cover in some stands. *Juniperus deppeana* may replace *Juniperus osteosperma* in southern stands. Other species of *Juniperus* such as *J. scopulorum* may be present in higher elevation stands. Shrub cover is sparse (<10% cover). If *Quercus gambelii* is present, it has less than 5% cover. Other associated shrubs may be present such as scattered *Brickellia californica, Cercocarpus montanus, Ericameria nauseosa, Eriogonum corymbosum, Fallugia paradoxa, Gutierrezia sarothrae, Opuntia* spp., *Purshia stansburiana, Rhus trilobata, Ribes cereum* or *Yucca* spp. The herbaceous layer is typically moderately dense and is dominated by the warm-season, perennial short grass, *Bouteloua gracilis.* Associated graminoids include *Aristida* spp., *Achnatherum hymenoides (= Oryzopsis hymenoides), Bouteloua curtipendula, Elymus elymoides, Koeleria macrantha, Hesperostipa comata (= Stipa comata), H. neomexicana (= Stipa neomexicana),* and *Pleuraphis jamesii (= Hilaria jamesii). Muhlenbergia montana* is absent or scarce (<1% cover). Forb cover is typically low, but may be moderately diverse. Species such as *Artemisia dracunculus, Eriogonum* spp., and *Oxytropis lambertii* are common.

CONSERVATION RANK G5

DATABASE CODE CEGL000778

MAP CLASSES

Two-needle Pinyon - Utah Juniper / Blue Grama Woodland corresponds to the map class Pinyon Pine –Utah Juniper / Blue Grama Woodland (map code 11) and vegetation cover modifier Pinyon Pine – Utah Juniper / Blue Grama Woodland (Sparse) (map code 12). The sparse modifier refers to association occurrences with less than 25% trees and greater than 15% herbaceous cover. Map class Pinyon Pine –Utah Juniper / Blue Grama Woodland includes the Pinyon Pine –Utah Juniper / Blue Grama Woodland association and the Two-needle Pinyon / Sparse Understory Forest association.

Pinyon Pine –Utah Juniper / Blue Grama Woodland occurs primarily within the environs of the study boundary and does not occur on Sunset Crater. It occurs mainly on the northern and eastern section of the project boundary. The total area mapped for map class 11 within Sunset Crater Volcano NM is 2 hectares within 5 polygons and the total area in the park environs is 361 hectares within 51 polygons. Map code 12 does not occur within Sunset Crater Volcano NM; however, the total area in the park environs is 33 hectares within 8 polygons.

COMMENTS

Sunset Crater Volcano National Monument

Two-needle Pinyon - Utah Juniper / Blue Grama Woodland association may have a sparse understory layer or be dominated by herbaceous species other than *Bouteloua gracilis*. If *Bouteloua gracilis* is present it is an indicator species for this association as currently classified. Further sampling within the Colorado Plateau is needed to determine if *Bouteloua gracilis* is a true indicator for this association.

Global Comments

The two *Pinus edulis / Bouteloua gracilis* plant associations are treated as phases in Stuever and Hayden (1997a). In the NVCS we are including stands with southern Great Plains, Chihuahua Desert floristic affinities in the *Pinus edulis – (Juniperus monosperma) / Bouteloua gracilis* Woodland (CEGL002151) and stands with the Colorado Plateau and Great Basin floristic affinities in the *Pinus edulis – (Juniperus osteosperma) / Bouteloua gracilis* Woodland (CEGL000778). Both of these associations may include stands codominated by *Juniperus deppeana* in their southern extent. Stuever and Hayden (1997a) also described *Juniperus deppeana* phase (recognized by its dominance in the stand) and hillslope phase, which occurs on slopes > 15% and may have low cover of grasses (<5% cover). More survey is needed to fully understand the distribution and ecological relationships between these 3 species of *Juniperus* and *Pinus edulis*.

REFERENCES

Stuever and Hayden 1997a

Pinus flexilis Woodland Alliance

COMMON NAME	Limber Pine Woodland Alliance
PHYSIOGNOMIC CLASS	Woodland (II.)
PHYSIOGNOMIC SUBCLASS	Evergreen woodland (II.A.)
PHYSIOGNOMIC GROUP	Temperate or subpolar needle-leaved evergreen woodland (II.A.4.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural (II.A.4.N.)
FORMATION	Rounded-crowned temperate or subpolar needle-leaved evergreen woodland (II.A.4.N.a.)
ALLIANCE	*Pinus flexilis* Woodland Alliance

CLASSIFICATION CONFIDENCE LEVEL Alliances are not ranked by NatureServe for classification confidence

USFS WETLAND SYSTEM Upland

RANGE

Sunset Crater Volcano National Monument

This alliance is found at high elevations on O'Leary Peak in the project environs.

Globally

Stands included in this widespread woodland alliance occur intermittently throughout the Rocky Mountains and on mountains and plateaus in the Great Basin and Colorado Plateau, and on breaks in the northwestern Great Plains. The alliance ranges from Montana to New Mexico and from western North Dakota to southern California. It also likely occurs in southern Alberta and southeastern British Columbia, Canada.

ENVIRONMENTAL DESCRIPTION

Sunset Crater Volcano National Monument

The one relevé sampled was found at an elevation of 2,725m on the southeastern side of O'Leary peak on a steep slope of 40%. The substrate was mainly cinder gravel and basaltic derived soils.

Globally

Woodlands included in this alliance occur intermittently from timberline to lower montane and foothill zones throughout much of the Rocky Mountains, on escarpments and other geographic breaks in the northwestern Great Plains, and in mountains in the Great Basin and southern California. Elevations range from 850-3500 m. Climate is semiarid, cold temperate. Annual precipitation patterns and amounts are variable, but locally the sites are typically xeric on exposed, windswept rocky slopes and ridges from subalpine to foothills and prairie breaks. Some stands are on eroded substrates and resemble 'badlands' while others may occur on lava flows. These open woodlands occur on all aspects, but are most common on dry south- and west-facing slopes. Soils are typically shallow, skeletal and coarse-textured such as gravelly, sandy loams or loams, but may include alkaline clays. Stands grow best on calcareous soils derived from limestone or sandstone, but parent material is variable and includes a variety of igneous, sedimentary, and metamorphic rocks. Depending on the stand, bedrock may include a mixture of andesite, basalt, cinder, lava, limestone, dolomite, granite, gneiss, quartzite, rhyolite, schist, sandstone, serpentine, or shale. Exposed bedrock is common and many stands have over 50% bare soil. Soil pH is typically neutral or slightly alkaline, but can range from acid to alkaline.

Adjacent vegetation at high elevations includes alpine meadows and shrublands and subalpine forests dominated by *Picea, Abies* or *Pseudotsuga*. Adjacent montane stands are dominated by *Pinus ponderosa, Pinus contorta* or *Pseudotsuga menziesii*. At lower elevations adjacent vegetation may include *Juniperus*-dominated woodland and savannas; shrublands dominated by species of *Artemisia, Cercocarpus*, or *Purshia tridentata*; dry prairie; or riparian woodland dominated by *Pseudotsuga menziesii*. The transition can be abrupt or an extended ecotone where the woodlands grade into a savanna.

MOST ABUNDANT SPECIES

Sunset Crater Volcano National Monument

Stratum	Species
Tree canopy	*Pinus flexilis, Pseudotsuga menziesii, Populus tremuloides*

Globally

Stratum	Species
Tree canopy	*Pinus flexilis, Pseudotsuga menziesii*

ASSOCIATED SPECIES

Sunset Crater Volcano National Monument

Brickellia grandiflora, Holodiscus dumosus, Ribes cereum

Globally

Abies concolor, Juniperus osteosperma, Juniperus scopulorum, Picea engelmannii Pinus albicaulis, Pinus balfouriana, Pinus contorta, Pinus jeffreyi, Pinus longaeva, Pinus ponderosa, Arctostaphylos uva-ursi, Artemisia arbuscula, Artemisia nova, Artemisia tridentata, Cercocarpus ledifolius, Juniperus communis, Mahonia repens, Purshia tridentata, Rhus trilobata, Shepherdia canadensis, Symphoricarpos oreophilus, Yucca glauca, Achnatherum hymenoides, Bouteloua gracilis, Calamagrostis purpurascens, Carex rossii, Festuca idahoensis, Festuca campestris, Leucopoa kingii, Koeleria macrantha, Pseudoroegneria spicata

VEGETATION DESCRIPTION

Sunset Crater Volcano National Monument

The one Limber Pine Woodland relevé had a total vegetation cover of 40%, with 35% absolute cover in the tree layer, 2% in the shrub layer, and 5% in the herbaceous layer. Sixteen species occurred in this relevé .

The dominant species within the tree layer were *Pinus flexilis* (12% absolute cover), *Pseudotsuga menziesii* (8% absolute cover), and *Populus tremuloides* (7% absolute cover). The DBH for *Pinus flexilis* ranged from 13-19cm (average 15cm), *Pseudotsuga menziesii* ranged from 30-93cm (average 36cm), and *Populus tremuloides* ranged from 13-77.6cm (average 59cm). Tree height was distributed between 3-20m.

The shrub and herbaceous layer were sparse (7% absolute cover) with the dominant species being *Brickellia californica, Holodiscus dumosus,* and *Ribes cereum*.

Globally

Stands included in this widespread woodland alliance occur locally on warm, dry, rocky, exposed sites in the Rocky Mountain west, northwestern Great Plains, and desert mountains in the Great Basin and in southern and eastern California. Stands have an open canopy typically 3-10 m tall, but individuals may reach 15 m. The stands are solely dominated or codominated by the evergreen needle-leaved tree *Pinus flexilis*. Other trees species that may be present to codominant vary by geography and elevation zones throughout the woodland's range. In the subalpine, *Pinus albicaulis, Picea engelmannii* or *Pseudotsuga menziesii* may be present. In the montane zone, *Pinus contorta, Pinus ponderosa* or *Pseudotsuga menziesii* are frequently present, and in the lower montane transition zone from woodlands to grasslands or shrublands, *Juniperus osteosperma* or *Juniperus scopulorum* may co-occur with *Pinus flexilis*. In California, associates may include *Abies concolor, Pinus albicaulis, Pinus balfouriana, Pinus contorta, Pinus jeffreyi*, and *Pinus longaeva* (Sawyer and Keeler-Wolf 1995).

The understory vegetation is typically sparse because sites are dry and have a large cover of rock. On stands occurring in the breaks in the plains, Johnston (1987) reported 18% exposed rock and 25% bare soil. A sparse shrub layer may be present. The taller shrubs may include *Artemisia tridentata, Cercocarpus ledifolius, Jamesia americana, Rhus trilobata, Shepherdia canadensis, Symphoricarpos oreophilus* and immature tree species. The most frequent low shrubs are *Arctostaphylos uva-ursi, Artemisia arbuscula, Artemisia nova, Juniperus communis, Mahonia repens, Purshia tridentata*, and *Yucca glauca*. The herbaceous layer often dominates the understory. The most common species are graminoids such as *Bouteloua gracilis, Calamagrostis purpurascens, Carex rossii, Festuca idahoensis, Festuca campestris, Leucopoa kingii (= Festuca kingii), Koeleria macrantha, Achnatherum hymenoides (= Oryzopsis hymenoides),* and *Pseudoroegneria spicata*. Scattered forbs may include species of *Achillea, Antennaria, Arenaria, Arnica, Astragalus, Erigeron, Eriogonum, Hymenopappus, Hymenoxys, Liatris,*

Sedum, *Solidago*, and *Thermopsis*. In six relevés in the Little Missouri National Grassland in western North Dakota, the average cover for each of the strata was trees 38%, shrubs 21%, graminoids 20%, and forbs 9% (USFS 1992).

DATABASE CODE A.540

MAP CLASSES
Limber Pine Woodland Alliance is mapped as map class Limber Pine Woodland, map code 13.

Limber Pine Woodland Alliance occurs only in the environs of the study boundary on O'Leary Peak. The total area mapped within the park environs is 13 hectares within 9 polygons.

COMMENTS
Sunset Crater Volcano National Monument
The one relevé sampled did not represent any of the previously described associations within the Limber Pine Woodland alliance. In order to classify this relevé it was placed at a coarser classification level within the Limber Pine Woodland alliance. This relevé may represent a new vegetation association, however sampling at additional locations is needed to verify this.

Global Comments
It may be difficult to determine which tree species are dominant in a mixed, montane or subalpine forest stand, especially when *Pinus flexilis* is seral on *Pseudotsuga menziesii* habitat type sites. Some stands included in this alliance are too sparse to be classified as woodlands, especially those growing on lava (Eggler 1941).

Global Dynamics
Although some of the conifers that are typically codominant in *Pinus flexilis* stands are late successional species, they are not likely to displace *Pinus flexilis*. This is because most of these stands occur on harsh sites where *Pinus flexilis* is more competitive than most other conifer species. These stands are generally considered to be topographic or edaphic 'climax' stands (Cooper 1975, Eyre 1980). Even in stands at lower elevations, such as prairie breaks, it is unlikely that other coniferous species will become dominant (Eyre 1980). Because *Pinus flexilis* occurs over a broad range of elevations, it can also be important as a post-fire seral species on drier sites in the Rocky Mountains (Cooper 1975, Peet 1988). Peet (1978) reported apparent competitive displacement with *Pinus flexilis* in Colorado. He noted that *Pinus flexilis* may dominate xeric sites from low to high elevations, except where *Pinus aristata* or *Pinus albicaulis* occur. There, *Pinus flexilis* is largely restricted to lower elevation, rocky sites. Peet (1978) also reported that *Pinus flexilis* occurs in the less xeric *Pinus contorta* and *Pinus ponderosa* habitats.

Birds and small mammals often eat and cache the large, wingless pine seeds. Most important is the Clark's nutcracker, which can transport the seeds long distances and cache them on exposed windswept sites (Lanner and Vander Wall 1980). This results in the regeneration of pines in clumps from forgotten caches (Eyre 1980, Steele et al. 1983).

REFERENCES
Cooper 1975, Eggler 1941, Eyre 1980, Lanner and Vander Wall 1980, Peet 1978, Peet 1988, Sawyer and Keeler-Wolf 1995, Steele et al. 1983, USFS 1992

Pinus ponderosa / Andropogon hallii Woodland

COMMON NAME	Ponderosa Pine / Sand Bluestem Woodland
PHYSIOGNOMIC CLASS	Woodland (II.)
PHYSIOGNOMIC SUBCLASS	Evergreen woodland (II.A.)
PHYSIOGNOMIC GROUP	Temperate or subpolar needle-leaved evergreen woodland (II.A.4.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural (II.A.4.N.)
FORMATION	Rounded-crowned temperate or subpolar needle-leaved evergreen woodland (II.A.4.N.a.)
ALLIANCE	*Pinus ponderosa* Woodland Alliance

CLASSIFICATION CONFIDENCE LEVEL Low Confidence. This association has been newly described at Sunset Crater Volcano NM. No global descriptions or conservation ranks have currently been assigned.

USFS WETLAND SYSTEM Upland

RANGE
Sunset Crater Volcano National Monument
Ponderosa Pine / Sand Bluestem Woodland occurs on cinder cones in Sunset Crater Volcano NM. It is found on the west side of Sunset Crater Volcano NM and on a cinder cone southeast of Sunset Crater Volcano NM. This association also occurs in the park environs in patches within the OHV area.

ENVIRONMENTAL DESCRIPTION
Sunset Crater Volcano National Monument
Only one relevé was sampled at an elevation of 2,200m with a slope of 42% and on cinder gravel.

MOST ABUNDANT SPECIES
Sunset Crater Volcano National Monument

Stratum	Species
Tree canopy	*Pinus ponderosa*
Herbaceous	*Andropogon hallii*

ASSOCIATED SPECIES
Sunset Crater Volcano National Monument
Artemisia campestris, Ericameria nauseosa, Oenothera sp.

VEGETATION DESCRIPTION
Sunset Crater Volcano National Monument
The total vegetation cover for the one relevé sampled was 25% with 15% absolute cover in the tree layer, 5% in the shrub layer, and 15% in the herbaceous layer. Nine species were recorded.

The tree layer was characterized by *Pinus ponderosa* with DBH ranging from 13-63cm (average 30cm). The tree heights were between 3-10m. The most abundant grass was *Andropogon hallii* (12% absolute cover). The shrub cover was sparse.

CONSERVATION RANK G?

DATABASE CODE CEGL005808

MAP CLASSES
Ponderosa Pine / Sand Bluestem Woodland is represented by map class Ponderosa Pine / Sand Bluestem Woodland (map code 20).

Ponderosa Pine / Sand Bluestem Woodland is mapped on Sunset Crater and in the southeastern corner of the project boundary in USDA-FS lands. The total area mapped in Sunset Crater Volcano NM is 15 hectares within 4 polygons and in the park environs 5 hectares within 3 map polygons.

Pinus ponderosa / Bouteloua gracilis Woodland

COMMON NAME	Ponderosa Pine / Blue Grama Woodland
PHYSIOGNOMIC CLASS	Woodland (II.)
PHYSIOGNOMIC SUBCLASS	Evergreen woodland (II.A.)
PHYSIOGNOMIC GROUP	Temperate or subpolar needle-leaved evergreen woodland (II.A.4.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural (II.A.4.N.)
FORMATION	Rounded-crowned temperate or subpolar needle-leaved evergreen woodland (II.A.4.N.a.)
ALLIANCE	*Pinus ponderosa* Woodland Alliance

CLASSIFICATION CONFIDENCE LEVEL Strong

USFS WETLAND SYSTEM Upland

RANGE

Sunset Crater Volcano National Monument

Ponderosa Pine / Blue Grama Woodland commonly occurs in the park environs and in the southeast corner of Sunset Crater Volcano NM. It is commonly found in the flat areas adjacent to Hwy 89 and FS road 776. It is also located at the base of cinder cones including Darton Dome, Robinson Mountain, and O'Leary Peak.

Globally

This ponderosa pine woodland occurs in the southern Rocky Mountains, extending east on southern Great Plains escarpments as far as Oklahoma, south to the mountains of West Texas, west to the Colorado Plateau and Mogollon Rim of New Mexico, Arizona, and southern Utah.

ENVIRONMENTAL DESCRIPTION

Sunset Crater Volcano National Monument

This association's elevation ranged from 2,050-2,250m (average 2,120m) and the slope ranged from 4-25% (average 12%).

Globally

This widespread woodland occurs at foothill and lower montane elevations from the southern Rocky Mountains, extending east on southern Great Plains escarpments, south to the mountains of West Texas, west to the Colorado Plateau and Mogollon Rim of New Mexico, Arizona and Utah. Elevation ranges from 1,740-2,610 m (5,700-8,550). Sites occur on dry, gentle to steep slopes on all aspects, but are more common on southern and western aspects, especially at higher elevations. Substrates are quite variable and include shallow sandy loam soils derive from granitic parent materials, coarse cinder soils and clayey soil with or without high coarse fragment content.

MOST ABUNDANT SPECIES

Sunset Crater Volcano National Monument

Stratum	Species
Tree canopy	*Pinus ponderosa*
Shrub	*Ericameria nauseosa*
Herbaceous	*Bouteloua gracilis*

Globally

Stratum	Species
Tree canopy	*Pinus ponderosa*
Herbaceous	*Bouteloua gracilis*

ASSOCIATED SPECIES

Sunset Crater Volcano National Monument

Artemisia carruthii, Artemisia dracunculus, Bromus tectorum, Elymus elymoides, Festuca arizonica, Muhlenbergia montana, Tetradymia canescens

Globally

Pinus edulis, Juniperus monosperma, J. osteosperma, J. deppeana, J. scopulorum, Artemisia tridentata, Ceanothus fendleri, Cercocarpus montanus, Chrysothamnus viscidiflorus, Ericameria nauseosa, Fallugia paradoxa, Purshia tridentata, Quercus grisea, Rhus trilobata, Tetradymia canescens, Bouteloua hirsuta, Carex geophila, Elymus elymoides, Hesperostipa comata, Koeleria macrantha, Muhlenbergia montana, Poa fendleriana, Schizachyrium scoparium, Artemisia ludoviciana, Eriogonum racemosa,Chaetopappa ericoides, Packera neomexicana.

VEGETATION DESCRIPTION

Sunset Crater Volcano National Monument

The Ponderosa Pine / Blue Grama Woodland has a total vegetation cover that ranges from 40-75% absolute cover (average 61%). The average cover for the tree layer ranged from 5-30% (average 15%), shrub layer 2-25% (average 8%), and herbaceous layer 30-50% (average 39%). Species richness ranged from 15-39 (average 24) in the three relevés measured.

The tree layer is dominated by *Pinus ponderosa*, with DBH ranging from 16-58cm (average 30cm). The shrub layer was often characterized by *Ericameria nauseosa* (1-35% absolute cover). The herbaceous layer is dominated by *Bouteloua gracilis* with 3-25% absolute cover (average 20%).

Globally

This plant association is characterized by an open to moderately dense, evergreen, needleleaf tree canopy 10-30 m tall that is either dominated by *Pinus ponderosa* or codominated by *Pinus ponderosa* and *Pinus edulis*. *Juniperus monosperma, J. osteosperma, J. deppeana* or *J. scopulorum* may be important subdominants. The typically moderately dense herbaceous layer has greater cover than the shrub layer, and is dominated by graminoids. *Bouteloua gracilis*, the warm-season, sod-forming, shortgrass dominates the herbaceous layer. Common graminoid associates include *Aristida* spp., *Bouteloua hirsuta, Carex geophila, Elymus elymoides, Hesperostipa comata, Koeleria macrantha, Muhlenbergia montana, Poa fendleriana,* or *Schizachyrium scoparium*. *Muhlenbergia montana* may be present, but only with low cover (<2%) and does not co-dominate. *Quercus gambelii* may be present in the sparse shrub layer (<10% cover) with low cover (<5%). Other shrubs may inclulde scattered *Artemisia tridentata, Ceanothus fendleri, Cercocarpus montanus, Chrysothamnus viscidiflorus, Ericameria nauseosa, Fallugia paradoxa, Purshia tridentata, Quercus grisea, Rhus trilobata*, and *Tetradymia canescens.* Forb cover is typially sparse and may include species such as *Antennaria* spp., *Artemisia ludoviciana, Erigeron* spp., *Eriogonum racemosa,Chaetopappa ericoides, Packera neomexicana*, and *Penstemon spp.*

CONSERVATION RANK G4

DATABASE CODE CEGL000848

MAP CLASSES

The association Ponderosa Pine / Blue Grama Woodland is represented by map class Ponderosa Pine / Montane Grass Mosaic (map code 15). Ponderosa Pine / Montane Grass Mosaic is a combined map class of Ponderosa Pine / Blue Grama Woodland and Ponderosa Pine / Mountain Muhly Woodland. These two associations were combined in one map class due to difficulties in photointerpreting the different grass understories under ponderosa pine canopy cover.

Ponderosa Pine / Montane Grass Mosaic is mapped as the dominant map class in the western section of the project boundary. This map class also occurs in a small patch on Darton Dome and in the southeastern section on Forest Service lands. The total area mapped in Sunset Crater Volcano NM is 3 hectares within 1 polygon and in the park environs 1223 hectares within 69 map polygons.

COMMENTS

Sunset Crater Volcano National Monument

This association has high variability in the shrub, tree, and herbaceous layer. With more relevés collected within the Colorado Plateau this association may be subdivided into additional associations.

Global Comments

This ponderosa pine woodland is a broadly defined plant association. Stuever and Hayden (1997b) report 6 phases: the *Bouteloua gracilis, Schizachyrium scoparium, Andropogon hallii, Artemisia tridentata, Quercus grisea,* and *Q. gambelii* phases. Hanks et al. 1983 described 4 phase of the *Pinus ponderosa/Bouteloua gracilis* Habitat Type from northern Arizona. More classification review is needed to further define the relationships between these phases and other similar plant associations. Alexander et al. (1987), DeVelice et al. (1986), and Muldavin et al. (1996) also described phases of this Habitat Type that need further review and cross-walking to NVCS. Youngblood and Mauk (1985) included stands of this association in their broadly defined *Pinus ponderosa/Muhlenbergia montana* Habitat Type.

Global Dynamics

Both diagnostic species are tolerant of ground fire. *Pinus ponderosa* develops thick fire-resistant bark that protects it from ground fires (Bradley et al. 1992). *Bouteloua gracilis* resprouts after burning and is unharmed by fires in years with above normal winter and spring precipitation, but can be severely damaged during drought years (Wright and Bailey 1980). Most *Pinus ponderosa* stands have relatively frequent fires (every 3-20 years), but fire are less frequent in dry, rocky stands where ground fire is limited by lack of continuous fine fuels (Stuever and Hayden 1997b). Fire-return interval has generally increased because of active fire suppression and historic livestock grazing, which has reduced the fine-fuels needed to carry ground fires (Madany and West 1980, Savage and Swetnam 1990). Absence of fire has led to large acculmulations of ground fuel and has likely resulted in denser stands and invasion of less fire-adapted, shade tolerant species species such as *Pseudotsuga menziesii*. This has likely increased risk of severe, stand replacing crown fires.

REFERENCES

Alexander et al. 1987, Bradley et al. 1992, , DeVelice et al. 1986, Hanks et al. 1983, Madany and West 1980, Stuever and Hayden 1997b, Savage and Swetnam 1990, Wright and Bailey 1980, Youngblood and Mauk 1985

Pinus ponderosa / Fallugia paradoxa Woodland

COMMON NAME	Ponderosa Pine / Apache Plume Woodland
SYNONYM	N/A
PHYSIOGNOMIC CLASS	Woodland (II.)
PHYSIOGNOMIC SUBCLASS	Evergreen woodland (II.A.)
PHYSIOGNOMIC GROUP	Temperate or subpolar needle-leaved evergreen woodland (II.A.4.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural (II.A.4.N.)
FORMATION	Rounded-crowned temperate or subpolar needle-leaved evergreen woodland (II.A.4.N.a.)
ALLIANCE	*Pinus ponderosa* Woodland Alliance

CLASSIFICATION CONFIDENCE LEVEL Low Confidence, Newly described at Sunset Crater Volcano NM. No additional global description data available.

USFS WETLAND SYSTEM Upland

RANGE
Sunset Crater Volcano National Monument
Ponderosa Pine / Apache Plume Woodland is one of the most common associations in Sunset Crater Volcano NM and also occurs frequently in the park environs. This association is found on level cinder areas and steeper cinder slopes in the eastern section of the park. It is also the most common association in the eastern half of the park environs.

ENVIRONMENTAL DESCRIPTION
Sunset Crater Volcano National Monument
Ponderosa Pine / Apache Plume Woodland was found on cinder gravel with a range of slopes (0-45%, average 11%). Elevation ranged from 1,975-2,450m (average 2,120m).

MOST ABUNDANT SPECIES
Sunset Crater Volcano National Monument

Stratum	Species
Tree canopy	*Pinus ponderosa*
Shrub	*Fallugia paradoxa*

ASSOCIATED SPECIES
Sunset Crater Volcano National Monument
Alhagi maurorum, Andropogon hallii, Bouteloua gracilis, Bromus tectorum, Eriogonum corymbosum, Ericameria nauseosa, Forestiera pubescens, Linum lewisii, Juniperus osteosperma, Pinus edulis, Pseudotsuga menziesii, Ribes cereum

VEGETATION DESCRIPTION
Sunset Crater Volcano National Monument
Ponderosa Pine / Apache Plume Woodland total vegetation cover ranged from 9-55% cover (average 24%). The tree layer ranged in absolute cover from 9-55% (average 24%), shrub layer ranged from 1-43% (average 6%), and herbaceous layer ranged from 1-20% (average 4%). The average total number of species per relevé ranged from 2-25 (average 11) as seen in 27 relevés.

Fallugia paradoxa dominated the shrub layer (1-45% absolute cover, average 9%). The tree layer is dominated by *Pinus ponderosa* (5-36% absolute cover, average 16%) with DBH ranging from 11-85cm (average 34cm). The herbaceous layer was sparse.

CONSERVATION RANK G?

DATABASE CODE CEGL002999

MAP CLASSES

Ponderosa Pine / Apache Plume Woodland is mapped as Ponderosa Pine / Apache Plume Woodland, Ponderosa Pine / Apache Plume Woodland (Sparse), and Ponderosa Pine / Apache Plume Woodland (Pinyon), represented respectively by map codes 17, 18, and 19.

The map class Ponderosa Pine / Apache Plume Woodland (Sparse) refers to relevés with less than 20% total vegetation cover and the map class Ponderosa Pine / Apache Plume Woodland (Pinyon) contains greater than 10% *Pinus edulis*.

Ponderosa Pine / Apache Plume Woodland and its modifiers are mapped as the predominant association in the eastern half of the project area. The total hectares mapped of Ponderosa Pine / Apache Plume Woodland in Sunset Crater Volcano NM is 354 and these occur within 70 polygons and in the park environs 1940 hectares within 187 polygons. This consists of map code 18 with 238 hectares and 18 polygons in Sunset Crater Volcano NM and 1650 hectares and 41 polygons in the park environs, map code 17 with 115 hectares and 51 polygons in Sunset Crater Volcano NM and 224 hectares and 127 polygons in the park environs, and map code 19 with 1 hectare and 1 polygon in Sunset Crater Volcano NM and 66 hectares and 19 polygons in the park environs.

COMMENTS

Sunset Crater Volcano National Monument

Depending on the spacing of trees, this map class may represent a mosaic of Ponderosa Pine / Apache Plume Woodland and Apache Plume (Four Wing Saltbush, Torrey's Joint Fir) Cinder Shrubland with Apache Plume (Four Wing Saltbush, Torrey's Joint Fir) Cinder Shrubland occurring in patches of 1,000m^2 or larger.

Pinus ponderosa / Muhlenbergia montana Woodland

COMMON NAME	Ponderosa Pine / Mountain Muhly Woodland
PHYSIOGNOMIC CLASS	Woodland (II.)
PHYSIOGNOMIC SUBCLASS	Evergreen woodland (II.A.)
PHYSIOGNOMIC GROUP	Temperate or subpolar needle-leaved evergreen woodland (II.A.4.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural (II.A.4.N.)
FORMATION	Rounded-crowned temperate or subpolar needle-leaved evergreen woodland (II.A.4.N.a.)
ALLIANCE	*Pinus ponderosa* Woodland Alliance

CLASSIFICATION CONFIDENCE LEVEL Strong

USFS WETLAND SYSTEM Upland

RANGE

Sunset Crater Volcano National Monument

Ponderosa Pine / Mountain Muhly Woodland occurs frequently in the park environs around Sunset Crater Volcano NM. It occurs most frequently in the northwestern section of the environs around Robinson Crater, Robinson Mountain, and O'Leary Peak. Also in the environs it occurs south of Bonito Park at the base of unnamed cinder cones.

Globally

This widespread woodland occurs at foothill and lower montane elevations in the southern Rocky Mountains, extending south to the mountains of West Texas, and west to the Mogollon Rim and Colorado Plateau of New Mexico, Arizona and Utah.

ENVIRONMENTAL DESCRIPTION

Sunset Crater Volcano National Monument

Ponderosa Pine / Mountain Muhly Woodlands occurs between an elevational range of 2,150-2,270m (average 2,200m). Slope is low to moderate and ranges from 1-35% (average 9%). Typically it is on cinder gravel.

Globally

This widespread woodland occurs at foothill and lower montane elevations in the southern Rocky Mountains, extending south to the mountains of West Texas, and west to the Mogollon Rim and Colorado Plateau. Elevation ranges from 2,150-2,870 m (7,050-9,400 feet). Stands occur on bottomlands, elevated plains, cinder cones, piedmont slopes, mesas, foothills, and mountains. Sites include gentle to steep slopes on all aspects, but are more common on southern and western aspects, especially at higher elevations. Substrates are variable, but are typically shallow, rocky, coarse-textured soils derived from granitic or cinder parent materials. There is considerable cover of bare soil and exposed bedrock.

MOST ABUNDANT SPECIES

Sunset Crater Volcano National Monument

Stratum	Species
Tree canopy	*Pinus ponderosa*
Herbaceous	*Muhlenbergia montana*

Globally

Stratum	Species
Tree canopy	*Pinus ponderosa Pinus edulis, Pinus discolor, Juniperus monosperma, Juniperus osteosperma, Juniperus deppeana, Juniperus scopulorum*
Herbaceous	*Muhlenbergia montana*

ASSOCIATED SPECIES

Sunset Crater Volcano National Monument

Artemisia carruthii, Bouteloua gracilis, Brickellia californica, Cercocarpus montanus, Cirsium wheeleri, Elymus elymoides, Ericameria nauseosa, Fallugia paradoxa, Festuca arizonica, Juniperus deppeana, Juniperus osteosperma, Mahonia fremontii, Muhlenbergia minutissima, Pinus edulis, Tetradymia canescens, Oxytropis lambertii, Schizachyrium scoparium, Quercus gambelii

Globally

Pinus edulis, Pinus discolor, Juniperus monosperma, J. osteosperma, J. deppeana, J. scopulorum, Artemisia tridentata, Brickellia californica, Ceanothus fendleri, Cercocarpus montanus, Chrysothamnus viscidiflorus, Ericameria nauseosa, Fallugia paradoxa, Quercus gambelii, Purshia tridentata, Quercus grisea, Rhus trilobata, Tetradymia canescens, Yucca baccata, Blepharoneuron tricholepis, Bouteloua gracilis, Carex geophila, C. rossii, Elymus elymoides, Koeleria macrantha, Poa fendleriana, Schizachyrium scoparium. Artemisia ludoviciana, Eriogonum racemosum, Chaetopappa ericoides, Lotus wrightii, Oxytropis lambertii, Packera neomexicana

VEGETATION DESCRIPTION

Sunset Crater Volcano National Monument

The total vegetation cover ranged from 22-50% (average 37%). The tree layer absolute cover ranged from 12-35% (average 22%), shrub layer ranged 0-9% (average 2%), and the herbaceous strata ranged from 7-35% (average 16%). The total species richness ranged from 12-37 species (average 24) as found on 12 relevés.

The tree layer was dominated by *Pinus ponderosa* with cover ranging from 5-36% (average 33%). DBH ranged from 11-99cm (average 31cm) and tree height ranged from 5-20m. The herbaceous layer was dominated by *Muhlenbergia montana* with 2-20% cover (average 9%). The shrub layer was sparse.

Globally

This association is characterized by an open to moderately dense, evergreen, needleleaf tree canopy to 10-30 m tall that is dominated or codominated by *Pinus ponderosa*. Associated tree species vary geographically. *Pinus edulis, Pinus discolor, Juniperus monosperma, J. osteosperma, J. deppeana* and *J. scopulorum* may be important in the tree canopy. *Psudotsuga menziesii, Pinus flexilis,* and *Populus tremuloides* may also be present, but are considered accidental. The typically moderately dense herbaceous layer has greater cover than the shrub layer, and is dominated by graminoids. *Muhlenbergia monatana,* a warm-season, medium-tall perennial typically dominates the herbaceous layer and is diagnostic of this association. *Bouteloua gracilis* may co-dominate. Common graminoid associates include *Aristida* spp., *Blepharoneuron tricholepis, Carex geophila, C. rossii, Elymus elymoides, Koeleria macrantha, Poa fendleriana* and *Schizachyrium scoparium*. *Festuca arizonica, Muhlenbergia virescens, M. dubia, M. emersleyi* and *Hesperostipa* spp. are typically absent. *Quercus gambelii* may be present with low cover (to 5%) in the sparse shrub layer (<10% cover). Other scattered shrubs may includle *Artemisia tridentata, Brickellia californica, Ceanothus fendleri, Cercocarpus montanus, Chrysothamnus viscidiflorus, Ericameria nauseosa, Fallugia paradoxa, Mahonia* spp., *Purshia tridentata, Quercus grisea, Rhus trilobata, Tetradymia canescens* or *Yucca baccata*. Forb cover is typially sparse and may include species such as *Antennaria* spp., *Artemisia ludoviciana, Erigeron* spp., *Eriogonum racemosa, Chaetopappa ericoides, Lotus wrightii, Oxytropis lambertii, Packera neomexicana,* and *Penstemon* spp.

CONSERVATION RANK G4G5

DATABASE CODE CEGL000862

MAP CLASSES

The association Ponderosa Pine / Mountain Muhly Woodland is represented by Ponderosa Pine / Montane Grass Mosaic (map code 15). Ponderosa Pine / Montane Grass Mosaic is a combined map class of Ponderosa Pine / Blue Grama Woodland and Ponderosa Pine / Mountain Muhly Woodland. These two associations were combined in one map class due to difficulties in photointerpreting the different grass understories under ponderosa pine canopy cover.

Ponderosa Pine / Montane Grass Mosaic is mapped as the dominant map class in the western section of the project boundary. This map class also occurs in a small patch on Darton Dome and in the southeastern section on Forest

Service lands. The total area mapped in Sunset Crater Volcano NM is 3 hectares within 1 polygon and in the park environs 1223 hectares within 69 map polygons.

COMMENTS

Global Comments

This ponderosa pine woodland is a broadly defined plant association. Stuever and Hayden (1997b) suggested the xeric upland and mesic bottomland stands be put into different phases. Fitzhugh et al. (1987) suggested it be divided into regional phases.

Global Dynamics

Both diagnostic species are tolerant of ground fire. *Pinus ponderosa* develops thick fire-resistant bark and *Muhlenbergia montana* resprouts after burning, although if may take a few years to recover to pre-burn density (Fischer and Bradley 1987, Bradley et al. 1992). This association had frequent fires (every 3-10 years on average) in pre-settlement times, but fires are less frequent in dry, rocky stands where ground fire is limited by lack of continuous fine fuels (Stuever and Hayden 1997a or b). Fire-return interval has generally increased because of active fire suppression and historic livestock grazing, which has reduced the fine-fuels needed to carry ground fires (Madany and West 1980, Savage and Swetnam 1990). Absence of fire has led to large acculmulations of ground fuel and has likely resulted in denser stands and invasion of less fire-adapted, shade tolerant species species such as *Pseudotsuga menziesii*. This has likely increased risk of stand replacing crown fires

Improper livestock grazing will favor the more grazing-tolerant species such as *Bouteloua gracilis*, and over time can may eliminate *Muhlenbergia montana* and convert the stand into a *Pinus ponderosa* / *Bouteloua gracilis* Woodland (CEGL000848).

REFERENCES

Bradley et al. 1992, Fischer and Bradley 1987, Fitzhugh et al. 1987, Madany and West 1980, Savage and Swetnam 1990, Stuever and Hayden 1997b

Pinus ponderosa / Cinder Woodland

COMMON NAME	Ponderosa Pine / Cinder Woodland
PHYSIOGNOMIC CLASS	Woodland (II.)
PHYSIOGNOMIC SUBCLASS	Evergreen woodland (II.A.)
PHYSIOGNOMIC GROUP	Temperate or subpolar needle-leaved evergreen woodland (II.A.4.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural (II.A.4.N.)
FORMATION	Rounded-crowned temperate or subpolar needle-leaved evergreen woodland (II.A.4.N.a.)
ALLIANCE	*Pinus ponderosa* Woodland Alliance

CLASSIFICATION CONFIDENCE LEVEL Low Confidence, Newly described at Sunset Crater Volcano NM. No additional global description data available.

USFS WETLAND SYSTEM Upland

RANGE
Sunset Crater Volcano National Monument
Ponderosa Pine / Cinder Woodland is one of the most common associations in the mapping project and is found on level and on steep slopped cinder. Within Sunset Crater Volcano NM it occurs in lower elevations on the north side of Sunset Crater. It predominates the central area of the park environs and occurs on O'Leary peak and in the surrounding lower elevation areas.

ENVIRONMENTAL DESCRIPTION
Sunset Crater Volcano National Monument
Ponderosa Pine / Cinder Woodlands elevation ranges from 2,020-2,300m (average 2,060m). The association occurs on steep slopes on cinder cones and flatter areas (0-45% slope, average 14%).

MOST ABUNDANT SPECIES
Sunset Crater Volcano National Monument

Stratum	Species
Tree canopy	*Pinus ponderosa*

ASSOCIATED SPECIES
Sunset Crater Volcano National Monument
Andropogon hallii, Bouteloua gracilis, Brickellia californica, Elymus elymoides, Ericameria nauseosa, Fallugia paradoxa, Festuca arizonica, Monardella odoratissima, Muhlenbergia montana, Oxytropis lambertii, Pinus edulis, Rhus trilobata, Ribes cereum

VEGETATION DESCRIPTION
Sunset Crater Volcano National Monument
The total vegetation cover ranged from 21-70% (average 36%). The tree layer absolute cover ranged from 19-55% (average 32%), the shrub layer 0.5-10% (average 3%), and the herbaceous strata 0.5-20% (average 3%). The total species richness ranged from 5-20 species (average 11) as measured on 22 relevés.

The tree layer was dominated by *Pinus ponderosa* (15-56% absolute cover, average 33%). DBH ranged from 11-99cm (average 31cm) with heights ranging 5-30m. The shrub layer was sparse and the herbaceous cover was low to sparse.

CONSERVATION RANK G?

DATABASE CODE CEGL002998

MAP CLASSES

The map class Ponderosa Pine / Cinder Woodland is mapped as Ponderosa Pine / Cinder Woodland and occurs as map code 14.

Ponderosa Pine / Cinder Woodland is mapped as a predominant map class in the central part of the project boundary. In Sunset Crater Volcano NM 93 hectares were mapped within 26 polygons; in the park environs 1038 hectares within 61 polygons.

COMMENTS

Sunset Crater Volcano National Monument

Ponderosa Pine / Cinder Woodland can be distinguished from Ponderosa Pine / Apache Plume Woodland by the understory shrub cover. Ponderosa Pine / Cinder Woodlands shrub layer absolute cover is <5% and Ponderosa Pine / Apache Plume Woodland shrub layer average absolute cover is >5%. This type is similar to *Pinus ponderosa / Bouteloua gracilis* Habitat Type, *Andropogon hallii* phase, previously described in Hanks et al. 1983.

REFERENCES

Hanks et al. 1983

Populus tremuloides / Cinder Woodland (Local Assemblage)

COMMON NAME Quaking Aspen / Cinder Woodland

CLASSIFICATION CONFIDENCE LEVEL Not Rated, Unique to Monument

USFS WETLAND SYSTEM Upland

RANGE
Sunset Crater Volcano National Monument
Quaking Aspen / Cinder Woodland is rare within Sunset Crater Volcano NM and in the environs. This association occurs in flat areas as well as on steep cinder slopes. It is found along the edge of the park roadside in the western section of Sunset Crater Volcano NM. It was also found on an unnamed cinder cone east of HWY 89. Only one relevé was sampled of this association and it occurred on the eastern slope of O'Leary Peak.

ENVIRONMENTAL DESCRIPTION
Sunset Crater Volcano National Monument
The one relevé that was sampled occurred at an elevation of 2,180m. This association can occur on steep slopes and flat areas. The slope of the sampled relevé was steep (68%). It is found on cinder sand and gravel.

MOST ABUNDANT SPECIES
Sunset Crater Volcano National Monument

Stratum	Species
Tree canopy	*Populus tremuloides*

ASSOCIATED SPECIES
Sunset Crater Volcano National Monument
Holodiscus dumosus, Juniperus osteosperma, Pinus ponderosa

VEGETATION DESCRIPTION
Sunset Crater Volcano National Monument
Only one relevé was sampled; it had a total vegetation cover of 35% with 29% absolute cover in the tree layer, 6% in the shrub layer, and 4% in the herbaceous layer. Twenty-three species occurred in the relevé .

The tree layer was characterized by *Populus tremuloides* (22% cover). The DBH ranged from 12-71cm (average 22cm). The shrub layer and the herbaceous layer were sparse.

MAP CLASSES
Quaking Aspen / Cinder Woodland was mapped as an inclusion in the surrounding vegetation classes due to mainly occurring in patches less than 0.5 hectares (minimum mapping unit) and being indistinguishable from the surrounding vegetation. However, a separate coverage (sucr_aspen) was developed to illustrate the few patches of this association.

COMMENTS
Sunset Crater Volcano National Monument
Populus tremuloides is a clonal species that grows in the cinder soils and the lava beds within Sunset Crater Volcano NM and in the environs. This species is of particular interest to park staff due to it typically occurring only in mountainous areas (McDougall 1973).

This monument-specific community must be further sampled on the Colorado Plateau to determine if it is unique to Sunset Crater Volcano NM or if it is found across the landscape. Currently it has no global information, conservation rank or database code. Observations and descriptions of additional occurrences are required to confirm it as an association within the NVCS.

REFERENCES

McDougall 1973

Fallugia paradoxa (*Atriplex canescens, Ephedra torreyana*) Cinder Shrubland

COMMON NAME	Apache Plume (Four Wing Saltbush, Torrey's Joint Fir) Cinder Shrubland
PHYSIOGNOMIC CLASS	Shrubland
PHYSIOGNOMIC SUBCLASS	Deciduous shrubland
PHYSIOGNOMIC GROUP	Cold-deciduous shrubland
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural Cold-deciduous shrubland
FORMATION	Broad-leaved and microphyllous evergreen extremely xeromorphic subdesert shrubland
ALLIANCE	*Fallugia paradoxa* Shrubland Alliance

CLASSIFICATION CONFIDENCE LEVEL Low Confidence, this association has only been described from Sunset Crater Volcano NM and Wupatki NM. No additional global description data available.

USFS WETLAND SYSTEM Upland

RANGE
Sunset Crater Volcano National Monument
Apache Plume (Four Wing Saltbush, Torrey's Joint Fir) Cinder Shrubland is a common association within the mapping area for Sunset Crater Volcano NM. It is found within Sunset Crater Volcano NM on cinder cones and in flat areas specifically on Sunset Crater and Lenox Crater. In the project environs this association is also seen on cinder cones and lower elevations areas. It was mapped on Darton Dome, Robinson Crater, Black Mountain, and in the surrounding more level areas.

ENVIRONMENTAL DESCRIPTION
Sunset Crater Volcano National Monument
Apache Plume (Four Wing Saltbush, Torrey's Joint Fir) Cinder Shrubland has an elevation that ranges from 2,130-2,440m (average 2,254m). The slope ranged from 7-50% (average 20%). It is generally found on cinder gravel.

MOST ABUNDANT SPECIES
Sunset Crater Volcano National Monument

Stratum	Species
Shrub	*Fallugia paradoxa*

ASSOCIATED SPECIES
Sunset Crater Volcano National Monument
Andropogon hallii, Eriogonum corymbosum, Pinus edulis, Pinus ponderosa

VEGETATION DESCRIPTION
Sunset Crater Volcano National Monument
Apache Plume (Four Wing Saltbush, Torrey's Joint Fir) Cinder Shrubland total vegetation cover ranged from 6-20% (average 14%). The tree layer was sparse (1-2% absolute cover), the shrub layer ranged from 3-15% absolute cover (average 8%), and herbaceous layer 1-8% (average 4%). Species richness among the four relevés measured ranged from 3-14 species (average 10 species).

The tree layer is sparse with scattered *Pinus ponderosa* and *Pinus edulis*. The shrub layer is the most defining stratum with *Fallugia paradoxa* cover ranging from 3-15% cover (average 10%). The herbaceous layer was sparse with no defining species.

Globally
This plant association also occurs at Wupatki NM. At Wupatki NM four wing saltbush (*Atriplex canescens*) and Torrey's joint-fir *(Ephedra torreyana)* commonly co-occur in this association. However, at Sunset Crater Volcano NM four wing saltbush and Torrey's joint-fir were never found to occur within the association.

CONSERVATION RANK G?

DATABASE CODE CEGL005806

MAP CLASSES
The association Apache Plume (Four Wing Saltbush, Torrey's Joint Fir) Cinder Shrubland is represented as Apache Plume / Cinder Sparse Vegetation (map code 5).

Apache Plume / Cinder Sparse Vegetation is mapped as occurring in small patches throughout the entire project area. The total area of Apache Plume / Cinder Sparse Vegetation mapped in Sunset Crater Volcano NM is 27 hectares within 33 polygons and in the park environs is 202 hectares within 159 polygons.

Fallugia paradoxa – Brickellia grandiflora – (*Holodiscus dumosus)* Scree Shrubland (Local Assemblage)

COMMON NAME — Apache Plume - Tasselflower Brickellbush – (Ocean Spray Scree) Scree Shrubland

CLASSIFICATION CONFIDENCE LEVEL Not Rated, Unique to Monument

USFS WETLAND SYSTEM — Upland

RANGE

Sunset Crater Volcano National Monument

The proposed association Apache Plume - Tasselflower Brickellbush – (Ocean Spray Scree) Scree Shrubland occurs on steep scree cinder slopes. This map class is unique within the Sunset Crater Volcano NM environs. The map class occurs on the slopes of Darton Dome, Roden Crater, and O'Leary Peak.

ENVIRONMENTAL DESCRIPTION

Sunset Crater Volcano National Monument

Apache Plume - Tasselflower Brickellbush – (Ocean Spray Scree) Scree Shrubland occurred at 2,380-2,750m (average 2,540) and on steep slopes (25-37%, average 29%). The substrate was basaltic boulders and cinder scree.

MOST ABUNDANT SPECIES

Sunset Crater Volcano National Monument

Stratum	Species
Shrub	*Holodiscus dumosus, Fallugia paradoxa, Brickellia grandiflora*

ASSOCIATED SPECIES

Sunset Crater Volcano National Monument

Artemisia dracunculus, Chamaebatiaria millefolium, Echinocereus sp., Ericameria nauseosa, Penstemon barbatus, Pinus edulis, Populus tremuloides, Ribes cereum, Verbascum thapsus

VEGETATION DESCRIPTION

Sunset Crater Volcano National Monument

Apache Plume - Tasselflower Brickellbush – (Ocean Spray Scree) Scree Shrubland had a total vegetation cover that ranged from 30-50% cover (average 43%). The tree layer was sparse 0-12% (average 4%). The shrub layer was dominant and ranged from 17-45% (average 32%). The herbaceous layer ranged from 3-15% (average 8%). Species richness was 16-24 (average 20%) among the three relevés sampled.

The shrub layer was dominant and consisted of a suite of species including *Holodiscus dumosus* (1-15% absolute cover), *Fallugia paradoxa* (2-17% absolute cover), and *Brickellia grandiflora* (0.5-10% absolute cover). The herbaceous layer was sparse.

MAP CLASSES

The proposed association Apache Plume - Tasselflower Brickellbush – (Ocean Spray Scree) Scree Shrubland is represented by map class Rock Outcrop and Scree Shrubland (Map Code 3). Rock Outcrop and Scree Shrubland combines both Apache Plume - Tasselflower Brickellbush – (Ocean Spray Scree) Scree Shrubland and Rubber Rabbitbrush - Mountain Tail-leaf Rock Outcrop Sparse Vegetation local vegetation assemblages. These two assemblages were combined into one map class due to occurring in very small patches in similar habits throughout the entire project area.

Rock Outcrop and Scree Shrubland was mapped as very small polygons throughout the entire project area. The total area of Rock Outcrop and Scree Shrubland mapped in Sunset Crater Volcano NM is less than 0.5 hectares within 2 polygons and in the park environs is 4 hectares within 11 polygons.

Pinus ponderosa / Rhus trilobata Shrubland (Local Assemblage)

COMMON NAME Ponderosa Pine / Three-leaved Sumac Shrubland

CLASSIFICATION CONFIDENCE LEVEL Not Rated, Unique to Monument

USFS WETLAND SYSTEM Upland

RANGE
Sunset Crater Volcano National Monument
Ponderosa Pine / Three-leaved Sumac occurs on steep cinder slopes. This map class is unique and occurs within the project environs. It occurs on cinder cones east of HWY 89 and east of Lenox Park.

ENVIRONMENTAL DESCRIPTION
Sunset Crater Volcano National Monument
Only one relevé was sampled within the Ponderosa Pine / Three-leaved Sumac. It occurred at an elevation of 2,200m on steep slopes (27%) and cinder gravel.

MOST ABUNDANT SPECIES
Sunset Crater Volcano National Monument

Stratum	Species
Tree canopy	*Pinus ponderosa*
Shrub	*Rhus trilobata*

ASSOCIATED SPECIES
Sunset Crater Volcano National Monument
Artemisia dracunculus, Ribes cereum

VEGETATION DESCRIPTION
Sunset Crater Volcano National Monument
Ponderosa Pine / Three-leaved Sumac had a total vegetation cover of 30%. The tree layer absolute cover was 5%, shrub layer 20%, and herbaceous layer 10%. Species richness was 24 species on one relevé.

The tree layer was sparse and consisted of a low cover (5%) of *Pinus ponderosa*. The shrub layer was the dominant layer with 17% cover of *Rhus trilobata*. The herbaceous layer was sparse.

MAP CLASSES
The proposed association Ponderosa Pine / Three-leaved Sumac is mapped as an inclusion of other surrounding map classes. This proposed association occurred mainly in areas less than 0.5 hectares (less than the minimum mapping unit) and therefore was not mapped as a unique map class.

COMMENTS
Sunset Crater Volcano National Monument
This vegetation type is known only from Sunset Crater NM. More inventory is needed to determine if it is more widespread and possibly develop a new NVC association.

Andropogon hallii Colorado Plateau Herbaceous Vegetation

COMMON NAME	Sand Bluestem Colorado Plateau Herbaceous Vegetation
PHYSIOGNOMIC CLASS	Herbaceous Vegetation (V.)
PHYSIOGNOMIC SUBCLASS	Perennial graminoid vegetation (V.A.)
PHYSIOGNOMIC GROUP	Temperate or subpolar grassland (V.A.5.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural (V.A.5.N.)
FORMATION	Tall sod temperate or subpolar grassland (V.A.5.N.d.)
ALLIANCE	*Andropogon hallii* Herbaceous Alliance

CLASSIFICATION CONFIDENCE LEVEL Low Confidence, Newly described at Sunset Crater and Wupatki NM. No additional global description data available.

USFS WETLAND SYSTEM Upland

RANGE
Sunset Crater Volcano National Monument
Sand Bluestem / Herbaceous Vegetation occurs on cinder cones and on flat areas within Sunset Crater Volcano NM and in the environs. This association occurs around the base of and on Sunset Crater. Within the environs it occurs in only small patches in the project environs.

ENVIRONMENTAL DESCRIPTION
Sunset Crater Volcano National Monument
Only two relevés were sampled within the Sand Bluestem / Herbaceous Vegetation, both on Sunset Crater. The elevation ranged from 2,300-2,250m. This association occurred on steep slopes (35 and 40%) in cinder gravel.

MOST ABUNDANT SPECIES
Sunset Crater Volcano National Monument

Stratum	Species
Herbaceous	*Andropogon hallii*

ASSOCIATED SPECIES
Sunset Crater Volcano National Monument
Eriogonum corymbosum, Monardella odoratissima, Pinus ponderosa

VEGETATION DESCRIPTION
Sunset Crater Volcano National Monument
Two relevés were sampled within this association and had a total vegetation cover of 16 and 43%. The tree layer was sparse (0-4%) the shrub layer was also sparse (0.5%) and the herbaceous layer (12-40%). The total species richness consisted of 12 and 13 species.

Occasional *Pinus ponderosa* and *Eriogonum corymbosum* were found in the sparse tree and shrub layers. The herbaceous cover was dominated by *Andropogon hallii* (10-40%).

CONSERVATION RANK G?

DATABASE CODE CEGL002785

MAP CLASSES
Sand Bluestem Herbaceous Vegetation was mapped as map code 7.

Sand Bluestem Herbaceous Vegetation was mapped as one of the dominant vegetation types on Sunset Crater Volcano NM and in a small patch in the western half of the project boundary. In Sunset Crater Volcano NM 32 hectares were mapped within 10 polygons; in the park environs only 1 hectare within 2 polygons was mapped.

Bouteloua gracilis Herbaceous Vegetation

COMMON NAME	Blue Grama Herbaceous Vegetation
PHYSIOGNOMIC CLASS	Herbaceous Vegetation (V.)
PHYSIOGNOMIC SUBCLASS	Perennial graminoid vegetation (V.A.5.N.e.)
PHYSIOGNOMIC GROUP	Temperate or subpolar grassland (V.A.5.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural (V.A.5.N.)
FORMATION	Short sod temperate or subpolar grassland (V.A.5.N.e.)
ALLIANCE	*Bouteloua gracilis* Herbaceous Alliance

CLASSIFICATION CONFIDENCE LEVEL Weak

USFS WETLAND SYSTEM Upland

RANGE

Sunset Crater Volcano National Monument

Blue Grama Herbaceous Vegetation is a common vegetation type that occurs in the western half of the project environs on level areas. It occurs in meadows and parks, such as in Bonito Park.

Globally

This plant association occurs in Arizona, New Mexico and Wyoming.

ENVIRONMENTAL DESCRIPTION

Sunset Crater Volcano National Monument

This association was sampled at an elevational range from 2,070-2,120m (average 2,100m). It occurred mainly in the flat areas in meadows with slope ranging from 0-15% (average 7%). The typical substrate consists of cinder sand and gravel.

Globally

This minor plant association is reported from in Arizona, New Mexico and Wyoming. Elevation ranges from 1,830-2,200m (6,000-7,200 feet). Sites are flat to gently sloping and include plains, plateaus and montane meadows. Substrates are variable and range from coarse-textured soils derived from sand, gravel or cinder to silty clay loam prairie soils.

MOST ABUNDANT SPECIES

Sunset Crater Volcano National Monument

Stratum	Species
Herbaceous	*Bouteloua gracilis*
Shrub	*Ericameria nauseosa*

Globally

Stratum	Species
Herbaceous	*Bouteloua gracilis*
Shrub	*Ericameria nauseosa*

ASSOCIATED SPECIES

Sunset Crater Volcano National Monument

Artemisia carruthii, Artemisia dracunculus, Bromus tectorum, Ericameria nauseosa, Elymus elymoides, Muhlenbergia montana, Pinus ponderosa

Globally

Bouteloua curtipendula, Elymus elymoides, Muhlenbergia montana, M. richardsonis, M. torreyi, Pascopyrum smithii, Pleuraphis jamesii, Sporobolus cryptandrus, Artemisia carruthii, Artemisia dracunculus

VEGETATION DESCRIPTION

Sunset Crater Volcano National Monument

Blue Grama Herbaceous Vegetation had a total vegetation cover ranging from 25-50% (average 42%). Absolute cover in the tree layer ranged from 0-2% (average 0.4%), in the shrub layer 0-6% (average 1.3%), and in the herbaceous layer 25-60% (average 44%). On the 5 relevés sampled species richness ranged from 6-28 species (average 14).

The tree layer was sparse with only an occasional *Pinus ponderosa*. The shrub cover is low/sparse, some relevés have >5% total cover of *Ericameria nauseosa*. The herbaceous layer is the most abundant with the characteristic species being *Bouteloua gracilis*.

Globally

This association is characterized by moderate to dense (25-80% cover) herbaceous layer that is strongely dominated by the warm season, perennial shortgrass, *Bouteloua gracilis*. Associated grasses are *Bouteloua curtipendula*, *Elymus elymoides*, *Muhlenbergia montana*, *M. richardsonis*, *M. torreyi*, *Pascopyrum smithii*, *Pleuraphis jamesii* (= *Hilaria jamesii*), *Sporobolus cryptandrus* and the introduced annual grass *Bromus tectorum*. Forb cover is sparse. Associated forb species include *Artemisia carruthii* and *Artemisia dracunculus*. Scattered *Ericameria nauseosa* shrubs and an occasional *Juniperus* spp, *Pinus edulis*, or *P. ponderosa* (in montane stands) tree may be present.

CONSERVATION RANK G4Q

DATABASE CODE CEGL001760

MAP CLASSES

Blue Grama Herbaceous Vegetation corresponds to the map classes Montane Grassland (map code 8), Montane Grassland (Rabbitbrush) (map code 9), and Montane Grassland (Bonito Park Historic Agricultural Field) (map code 10). The Rabbitbrush modifier refers to the Blue Grama Herbaceous Vegetation association with >5% total cover of *Ericameria nauseosa*. The Bonito Park Historic Agricultural Field was delineated from aerial photographs as a previous area of agricultural activity. This type was not floristically different from the Blue Grama Herbaceous Vegetation; however, it was evident as an area of past disturbance. Montane Grassland includes both the Blue Grama Herbaceous Vegetation and Mountain Muhly Herbaceous Vegetation associations. These two grasses were combined into one map class, due to often occurring as co-dominates and being indistinguishable from aerial photography.

Montane Grassland occurs mainly in small patches throughout the western half of the project boundary only in the project environs. It was not mapped in Sunset Crater Volcano NM. The total area of Montane Grassland mapped in the park environs is 349 hectares within 156 polygons, this includes 148 hectares and 104 polygons in map code 8, 100 hectares and 51 polygons in map code 9, and 101 hectares and 1 polygon in map code 10.

COMMENTS

Global Comments

This is a low confidence association. There are many other associations in the *Bouteloua gracilis* Herbaceous Alliance (A.1282).

Global Dynamics

Bouteloua gracilis is an extremely drought- and grazing-tolerant shortgrass species. It is one of the most widely distributed grasses in the interior western U.S., and is present in many different grassland, shrubland and woodland communities. It evolved with grazing by large herbivores and generally forms a short sod. However, in some stands ungrazed plants develop the upright physiognomy of a bunchgrass.

Muhlenbergia montana Herbaceous Vegetation

COMMON NAME	Mountain Muhly Herbaceous Vegetation
PHYSIOGNOMIC CLASS	Herbaceous Vegetation (V.)
PHYSIOGNOMIC SUBCLASS	Perennial graminoid vegetation (V.A.)
PHYSIOGNOMIC GROUP	Temperate or subpolar grassland (V.A.5.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural (V.A.5.N.)
FORMATION	Medium-tall bunch temperate or subpolar grassland (V.A.5.N.d.)
ALLIANCE	*Muhlenbergia montana* Herbaceous Vegetation

CLASSIFICATION CONFIDENCE LEVEL Moderate

USFS WETLAND SYSTEM Upland

RANGE

Sunset Crater Volcano National Monument

Mountain Muhly Herbaceous Vegetation is a common grassland community that mainly occurs in high elevation mountain meadows. In the environs it occurs mainly in the northwestern section of the environs near Robinson Mountain.

Globally

This plant association forms meadows in the mountains and foothills of Colorado, Arizona and Utah.

ENVIRONMENTAL DESCRIPTION

Sunset Crater Volcano National Monument

This association is represented by one relevé sampled at an elevation of 2,300m. It was sampled in a small mountain meadow with gentle slope (10%). The soil consisted of cinder sand and gravel.

Globally

This plant association has been described from meadows in the mountains, plateaus and foothills of Colorado, Arizona and Utah. Elevation ranges from 2,300- 2,800 m (7,540-9,200 feet). Sites are typically xeric forest openings or parks in the Ponderosa Pine zone with southern aspects on moderately steep slopes and ridgetops. Occasionally the stands occupy rolling parklands or volcanic cinder fields. The xeric nature of sites appears to be an important environmental factor. Substrates are shallow to moderately deep, rocky, sand to sandy loam textured soils sometimes with a distinct clay horizon. Parent materials are primarily colluvium derived from granite and gneiss or cinder. Bare soil, exposed gravels, and small rocks account for as much as 50% of the ground surface area.

MOST ABUNDANT SPECIES

Sunset Crater Volcano National Monument

Stratum	Species
Herbaceous	*Muhlenbergia montana*

Globally

Stratum	Species
Herbaceous	*Muhlenbergia montana*

ASSOCIATED SPECIES

Sunset Crater Volcano National Monument

Bromus tectorum, Ericameria nauseosa, Pinus ponderosa

Globally

Blepharoneuron tricholepis, Trisetum spicatum, Bouteloua curtipendula, Bouteloua gracilis, Carex duriuscula, Danthonia parryi, Elymus albicans, Festuca brachyphylla, Hesperostipa comata, Koeleria macrantha, Muhlenbergia filiculmis, Pascopyrum smithii, Poa secunda, Schizachyrium scoparium, Allium geyeri, Antennaria rosea, Arenaria fendleri, Eriogonum umbellatum, Harbouria trachypleura, Heterotheca villosa, Mertensia lanceolata, Opuntia polyacantha, Penstemon secundiflorus, Phlox diffusa, Artemisia frigida, Ericameria nauseosa

VEGETATION DESCRIPTION

Sunset Crater Volcano National Monument

Mountain Muhly Herbaceous Vegetation had a total vegetation cover of 35%. Absolute cover in the tree layer was 4%, 3% in the shrub layer, and 25% in the ground layer. Species richness consisted of 20 species.

Within the tree layer the cover is sparse with an occasional *Pinus ponderosa*. The shrub layer is also sparse with a low cover of *Ericameria nauseosa*. The herbaceous layer was characterized by *Muhlenbergia montana* (15% absolute cover).

Globally

This association is characterized by a moderately dense herbaceous layer that is typically dominated by the warm-season, perennial bunchgrass, *Muhlenbergia montana*, but may be codominated by *Blepharoneuron tricholepis* or *Trisetum spicatum (= Trisetum montanum)* (in New Mexico). Other associated graminoids include *Bouteloua curtipendula, Bouteloua gracilis, Carex duriuscula (= Carex eleocharis), Danthonia parryi, Elymus albicans (= Elymus lanceolatus ssp. albicans), Festuca brachyphylla, Hesperostipa comata, Koeleria macrantha, Muhlenbergia filiculmis, Pascopyrum smithii, Poa secunda,* and *Schizachyrium scoparium*. The typically sparse forb layer often consists of *Allium geyeri, Antennaria rosea, Arenaria fendleri, Eriogonum umbellatum, Harbouria trachypleura, Heterotheca villosa, Mertensia lanceolata, Opuntia polyacantha, Penstemon secundiflorus* and *Phlox diffusa.* Except for the abundant dwarf-shrub *Artemisia frigida*, scattered *Ericameria nauseosa* shrubs or occasional *Pinus ponderosa* trees, woody species are very sparse or absent. The exotic grasses *Poa pratensis* and *Bromus tectorum* are common in some of these stands. Diagnostic of this grassland association is the dominance of *Muhlenbergia montana* in the herbaceous layer and low cover of *Festuca arizonica*.

CONSERVATION RANK G3G4

DATABASE CODE CEGL001646

MAP CLASSES

Mountain Muhly Herbaceous Vegetation corresponds to the map classes Montane Grassland (map code 8), Montane Grassland (Rabbitbrush) (map code 9), and Montane Grassland (Bonito Park Historic Agricultural Field) (map code 10). The Rabbitbrush modifier refers to the Mountain Muhly Herbaceous Vegetation association with >5% total cover of Ericameria nauseosa. The Bonito Park Historic Agricultural Field was delineated from aerial photographs as a previous area of agricultural activity. This area is not predominantly mountain muhly dominated; however, it occurs within the Montane Grassland map class. Montane Grassland includes both Blue Grama Herbaceous Vegetation and Mountain Muhly Herbaceous Vegetation associations. These two grass associations were combined into one map class, due to often occurring as co-dominates and indistinguishable from aerial photography.

Montane Grassland is mapped as occurring mainly in small patches throughout the western half of the project boundary and only occurs in the project environs and was not mapped as occurring in Sunset Crater Volcano NM. The total area of Montane Grassland mapped in the park environs is 349 hectares within 156 polygons, this includes 148 hectares and 104 polygons in map code 8, 100 hectares and 51 polygons in map code 9, and 101 hectares and 1 polygon in map code 10.

COMMENTS

Global Dynamics

Muhlenbergia montana often grows in association with montane conifer forests, especially ones dominated by *Pinus ponderosa* and has developed a tolerance for relatively frequent fire regimes. Although *Muhlenbergia montana* resprouts after burning, it may take a few years to recover to pre-burn density (Fischer and Bradley 1987) These grasslands may be considered seral or an edaphic climax depending if there are environmental factors, such as aridity, that are preventing establishment of trees. Historically, much of the area where this association occurs was heavily grazed by livestock, primarily sheep and cattle (Shepherd 1975). Season of use is important in stands with both *Hesperostipa comata* and *Muhlenbergia montana*, fall grazing will favor *Hesperostipa comata* over the later blooming *Muhlenbergia montana* (Clary 1978). The reverse is true if grazing is always limited to summer. Overgrazing will reduce or eliminate *Hesperostipa comata*, *Muhlenbergia montana* and the other palatable species,

leaving the more grazing-tolerant *Bouteloua gracilis* and less palatable plants such as *Hymenoxys, Artemisia* and *Chrysothamnus* species to dominate the site Clary (1978).

REFERENCES

Clary 1978, Fischer and Bradley 1987, Shepherd 1975

Pascopyrum smithii Herbaceous Vegetation

COMMON NAME	Western wheatgrass Herbaceous Vegetation
PHYSIOGNOMIC CLASS	Herbaceous vegetation (V.)
PHYSIOGNOMIC SUBCLASS	Perennial graminoid vegetation (V.A.)
PHYSIOGNOMIC GROUP	Temperate or subpolar grassland (V.A.5.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural (V.A.5.N.)
FORMATION	Medium-tall sod temperate or subpolar grassland (V.A.5.N.c.)
ALLIANCE	*Pascopyrum smithii* Herbaceous Alliance

CLASSIFICATION CONFIDENCE LEVEL Weak

USFS WETLAND SYSTEM Upland

RANGE

Sunset Crater Volcano National Monument

Western Wheatgrass Herbaceous Vegetation is an uncommon association only found in the project environs. It occurs in sites that were recently burned and have high disturbance (i.e. roadsides, cinder quarries) to the west of Robinson Mountain and on Robinson Crater.

ENVIRONMENTAL DESCRIPTION

Sunset Crater Volcano National Monument

The two relevés sampled within this association both occurred at an elevation of 2,160m. The slope was nearly flat (2-3%) and the substrate was cinder sand and gravel.

Globally

This grassland association is widespread in the northern and western Great Plains, Rocky Mountains, the intermountain western United States and possibly Canada. Elevation ranges from 600-3,000m. Stands occur on level to gently sloping terrain. They are found on alluvial fans, swales, river terraces, floodplains, valley bottoms and basins. The soils are deep (40-100 cm) and well-developed with clay, clay loam, and silt loam textures. Some stands occur on perched water tables

MOST ABUNDANT SPECIES

Sunset Crater Volcano National Monument

Stratum	Species
Herbaceous	*Pascopyrum smithii*

Globally

Stratum	Species
Herbaceous	*Pascopyrum smithii*

ASSOCIATED SPECIES

Sunset Crater Volcano National Monument

Bromus tectorum, Cirsium wheeleri, Pinus ponderosa

Globally

Eleocharis palustris, Koeleria macrantha, Poa fenderiana, Bouteloua gracilis, Hesperostipa comata, Nassella viridula, Artemisia frigida, Artemisia ludoviciana, Ericameria nauseosa, Krascheninnikovia lanata

VEGETATION DESCRIPTION

Sunset Crater Volcano National Monument

Western Wheatgrass Herbaceous Vegetation had a total vegetation cover of 30- 45%. Absolute cover in the tree layer was 0-10%, 0-0.5% in the shrub layer, and 22-45% in the herbaceous layer. Species richness consisted of 16 species in both relevés.

Within the tree layer the cover is sparse with an occasional *Pinus ponderosa*. The shrub layer is also sparse with only an occasional shrub. The herbaceous layer was characterized by *Pascopyrum smithii* with 20-35% total cover.

Globally

This association is characterized by a moderate to dense (40-100% cover) mixed grass herbaceous canopy that grows 0.5-1 m tall and is strongly dominated by *Pascopyrum smithii*. Other graminoids that co-occur and may achieve local dominance are *Koeleria macrantha, Eleocharis palustris*, and *Poa* spp. Many other species common in midgrass prairies are also found in this community. These include *Artemisia frigida, Artemisia ludoviciana, Achillea* sp., *Carex* spp., *Cirsium* spp., *Eriogonum* spp., *Bouteloua gracilis, Nassella viridula*, and *Hesperostipa comata (= Stipa comata)*. Shrubs and dwarf-shrubs are rare in this community, but occasional woody plants such as *Symphoricarpos* spp., *Ericameria nauseosa*, or *Krascheninnikovia lanata* may be present. Introduced species, such as *Bromus tectorum, Bromus inermis, Poa pratensis, Melilotus* spp., *Cirsium arvense, Taraxacum officinale*, or *Salsola kali*, are common in some stands, especially where disturbed.

CONSERVATION RANK G3G5Q

DATABASE CODE CEGL001577

MAP CLASSES

Western Wheatgrass Herbaceous Vegetation corresponds to the map class Ponderosa Pine Invasive Herbaceous Vegetation (map code 16). Western wheatgrass is not an invasive species; however, it is often associated with reseeding efforts and other areas of disturbance and therefore was lumped into this map class. Ponderosa Pine Invasive Herbaceous Vegetation includes both the Western Wheatgrass Herbaceous Vegetation and Ponderosa Pine Wooded Invasive Herbaceous Vegetation associations.

Ponderosa Pine Invasive Herbaceous Vegetation is mapped as occurring mainly in the northwestern half of the project environs around the base of cinder cones and on a cinder hill south of Bonito Park. It is not mapped as occurring in Sunset Crater Volcano NM. The total area of Ponderosa Pine Invasive Herbaceous Vegetation mapped in the park environs is 309 hectares within 19 polygons.

COMMENTS

Sunset Crater Volcano National Monument

Pascopyrum smithii is native to the United States; but it is not native to Arizona. However, *Pascopyrum smithii* is used in re-vegetation reseeding efforts by the Forest Service (FEIS 2001) and was possibly used to reseed the burned area northwest of Sunset Crater.

Global Comments

This community is similar to several others that are dominated or codominated by *Pascopyrum smithii*. As currently defined, it represents a western Great Plains and foothills version of the western wheatgrass types in the central Great Plains. Further work needs to be done to refine the differences in composition and environmental characteristics. See recent descriptions by Thilenius et al. (1995) (*Pascopyrum smithii* sodgrass steppe, a more playa-like wheatgrass type) and by Steinauer and Rolfsmeier (2000). In Nebraska, Steinauer and Rolfsmeier (2000) suggest that their stands may resemble *Pascopyrum smithii - Nassella viridula* Herbaceous Vegetation (CEGL001583).

Global Dynamics

In semi-arid climates, this association is found in relatively mesic topographic positions such as swales, river terraces, floodplains and basins that may be temporarily or intermittently flooded or in some classes, the fine textured soil sometimes perches the water table (Hansen et al. 1995, Hall and Hansen 1997). In more mesic climates it is found in extensive upland areas.

REFERENCES

FEIS 2001, Hall and Hansen 1997, Hansen et al. 1995, Steinauer and Rolfsmeier 2000, Thilenius et al. 1995

Pinus ponderosa Wooded Invasive Herbaceous Vegetation (Local Assemblage)

COMMON NAME Ponderosa Pine Invasive Herbaceous Vegetation

CLASSIFICATION CONFIDENCE LEVEL Not Rated, Unique to Monument

USFS WETLAND SYSTEM Upland

RANGE
Sunset Crater Volcano National Monument
Ponderosa Pine Invasive Herbaceous Vegetation occurs in areas of disturbance. Frequently the association is located where intensive logging activity has historically occurred. This association is mostly found in the project environs near Robinson Mountain.

ENVIRONMENTAL DESCRIPTION
Sunset Crater Volcano National Monument
This association was sampled at an elevation range of 2,140-2,220m (average 2,200m). Slope varied from steep to none (0-20%) (average 9%). It was found on cinder sand and gravel.

MOST ABUNDANT SPECIES
Sunset Crater Volcano National Monument

Stratum	Species
Tree canopy	*Pinus ponderosa*
Herbaceous	*Bromus tectorum*

ASSOCIATED SPECIES
Sunset Crater Volcano National Monument
Artemisia dracunculus, Geranium caespitosum, Junipers osteosperma, Linaria dalmatica ssp. dalmatica, Ribes cereum, Thalictrum fendleri

VEGETATION DESCRIPTION
Sunset Crater Volcano National Monument
Ponderosa Pine Wooded Invasive Herbaceous Vegetation had a total cover of 28- 45% (average 38%). Absolute cover in the tree layer ranged from 5-25% (average 15%), in the shrub layer 2-5% (average 3%), and in the herbaceous layer 17-25% (average 15%). Species richness for all three relevés ranged from 19-23 species (average 21).

The tree layer was dominated by *Pinus ponderosa* with cover ranging from 5-25%. DBH for *Pinus ponderosa* ranged from 11-87cm (average 19cm). The shrub cover is sparse. The herbaceous layer consisted of a variety of weedy native and non-native species, most often dominated by *Bromus tectorum* (0.5-20% absolute cover) and *Artemisia dracunculus* that ranged from (0.5-15% absolute cover).

MAP CLASSES
Ponderosa Pine Invasive Herbaceous Vegetation is mapped as Ponderosa Pine Invasive Herbaceous Vegetation (map code 16). Ponderosa Pine Invasive Herbaceous Vegetation includes both the Western Wheatgrass Herbaceous Vegetation and Ponderosa Pine Wooded Invasive Herbaceous Vegetation associations. These two associations were combined into one map class due to both occurring in previously disturbed areas and in areas that were reseeded after recent burns.

Ponderosa Pine Invasive Herbaceous Vegetation is mapped as occurring mainly in the northwestern half of the project environs around the base of cinder cones and on a cinder hill south of Bonito Park. It is not mapped as occurring in Sunset Crater Volcano NM. The total area of Ponderosa Pine Invasive Herbaceous Vegetation mapped in the park environs is 309 hectares within 19 polygons.

COMMENTS

Sunset Crater Volcano National Monument

Ponderosa Pine Invasive Herbaceous Vegetation had a variety of understory weedy herbaceous species that varied in composition and abundance between measured relevés. The herbaceous layer may vary annually and further data collection will be needed to understand the ecology and long-term dynamics of this association within Sunset Crater environs.

This unique community must be further sampled on the Colorado Plateau to determine if it is unique to Sunset Crater Volcano NM or if it is found across the landscape. Currently it has no global information, conservation rank or database code. Observations and descriptions of additional occurrences are required to confirm it as an association within the NVCS.

Ericameria nauseosa – Pericome caudata Rock Outcrop Sparse Vegetation (Local Assemblage)

COMMON NAME Rubber Rabbitbrush - Mountain Tail-leaf Rock Outcrop Sparse Vegetation

CLASSIFICATION CONFIDENCE LEVEL Not Rated, Unique to Monument

USFS WETLAND SYSTEM Upland

RANGE
Sunset Crater Volcano National Monument
Proposed association Rubber Rabbitbrush - Mountain Tail-leaf Rock Outcrop Sparse Vegetation occurs as small isolated stands of vegetation on lava outcrops within cinder barrens. It is found within Sunset Crater Volcano on cinder cones and within cinder barrens in the northern section of the park. In the project environs this vegetation type occurs mainly on the cinder barrens in the northeastern section of the mapping zone and on cinder cones in the northwestern section of the mapping zone.

ENVIRONMENTAL DESCRIPTION
Sunset Crater Volcano National Monument
Only one relevé was sampled of Rubber Rabbitbrush - Mountain Tail-leaf Rock Outcrop Sparse Vegetation. It had an elevation of 2100m, a slope of 10%, and was on lava outcrops within cinder barrens.

MOST ABUNDANT SPECIES
Sunset Crater Volcano National Monument

Stratum	Species
Shrub	*Ericameria nauseosa, Pericome caudata*

VEGETATION DESCRIPTION
Sunset Crater Volcano National Monument
In the one sampled relevé of Rubber Rabbitbrush - Mountain Tail-leaf Rock Outcrop Sparse Vegetation total vegetation cover was 7%. The relevé was sparse and within the tree layer the cover was 1%, the shrub layer 6%, and the herbaceous layer 2%. The tree and herbaceous layer were sparse. The shrub layer consisted of *Ericameria nauseosa* (2%) and *Pericome caudata* (3%). Species richness was low with only six species.

MAP CLASSES
The proposed association Apache Plume - Tasselflower Brickellbush – (Ocean Spray Scree) Scree Shrubland is represented by map class Rock Outcrop and Scree Shrubland (Map Code 3). Rock Outcrop and Scree Shrubland combines both Apache Plume - Tasselflower Brickellbush – (Ocean Spray Scree) Scree Shrubland and Rubber Rabbitbrush - Mountain Tail-leaf Rock Outcrop Sparse Vegetation local vegetation assemblages. These two assemblages were combined into one map class due to occurring in very small patches in similar habits throughout the entire project area.

This was mapped as very small polygons throughout the entire project area. The total area of Rock Outcrop and Scree Shrubland mapped in Sunset Crater Volcano is less than 0.5 hectares within 2 polygons and in the park environs is 4 hectares within 11 polygons.

COMMENTS
Sunset Crater Volcano National Monument
This monument specific community must be further sampled on the Colorado Plateau to determine if it is unique to Sunset Crater Volcano NM or if it is found across the landscape. Currently it has no global information, conservation rank or database code. Observations and descriptions of additional occurrences are required to confirm it as an association within the NVCS.

Eriogonum corymbosum Cinder Sparse Vegetation

COMMON NAME	Wild Buckwheat Cinder Sparse Vegetation
PHYSIOGNOMIC CLASS	Sparse Vegetation
PHYSIOGNOMIC SUBCLASS	Unconsolidated material sparse vegetation
PHYSIOGNOMIC GROUP	Sparsely vegetated soil slopes
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural Sparsely vegetated soil slopes
FORMATION	Dry slopes
ALLIANCE	*Eriogonum corymbosum* Sparsely Vegetated Alliance

CLASSIFICATION CONFIDENCE LEVEL This association has only been described from Sunset Crater Volcano and Wupatki NM. Until further data is collected regionally there is no global information or conservation rank.

USFS WETLAND SYSTEM Upland

RANGE

Sunset Crater Volcano National Monument

Wild Buckwheat Cinder Sparse Vegetation occurs in Sunset Crater Volcano on steep cinder cones. This association was mapped on Sunset Crater as well as on other unnamed cinder cones. It also occurs in the project environs on cinder cones mainly in the eastern section of the project boundary. This association was mapped on Black Mountain.

Globally

This assocation was also found to occr at Wuatki NM.

ENVIRONMENTAL DESCRIPTION

Sunset Crater Volcano National Monument

The relevé sampled for this association occurred at 2,320m, on a steep slope (30%) in cinder gravel.

MOST ABUNDANT SPECIES

Sunset Crater Volcano National Monument

Stratum	Species
Shrub	*Eriogonum corymbosum*
Herbaceous	*Andropogon hallii*

ASSOCIATED SPECIES

Sunset Crater Volcano National Monument

Pinus ponderosa

VEGETATION DESCRIPTION

Sunset Crater Volcano National Monument

Wild Buckwheat Cinder Sparse Vegetation had a total vegetation cover of 10%. There was no tree cover. The shrub layer had 2% absolute cover, 8% absolute cover was recorded in the herbaceous layer. Species richness within the relevé consisted of 7 species.

The one relevé measured had sparse vegetation cover. *Eriogonum corymbosum* was dominant with 7% cover within the shrub and ground layers collectively. The herbaceous layer had sparse *Andropogon hallii* (1% absolute cover).

CONSERVATION RANK G?

DATABASE CODE CEGL005803

MAP CLASSES

Wild Buckwheat Cinder Sparse Vegetation corresponds to the map class Wild Buckwheat / Sand Bluestem Sparse Vegetation (map code 4). Originally, the proposed association considered sand bluestem (*Andropogon hallii*) to be an important component to the understory community; however, with additional data collected at Wupatki NM sand

bluestem was no longer considered a dominant understory species throughout the plant association's range. Sand bluestem often co-occurs in this map class at Sunset Crater Volcano NM and therefore the map class of Wild Buckwheat / Sand Bluestem Sparse Vegetation was retained on the vegetation map. Wild Buckwheat / Sand Bluestem Vegetation is mapped as occurring in only small patches on steep cinder cones. It occurs in Sunset Crater Volcano NM in 11 polygons, 15 hectares, and occurs in the project environs in 23 polygons, 32 hectares.

Pinus ponderosa – (Populus tremuloides) / Fallugia paradoxa – (Holodiscus dumosus) Lava Bed Sparse Vegetation

COMMON NAME	Ponderosa pine – (Quaking Aspen) / Apache Plume – (Ocean Spray Scree) Lava Bed Sparse Vegetation
PHYSIOGNOMIC CLASS	Sparse Vegetation (VII.)
PHYSIOGNOMIC SUBCLASS	Boulder, gravel, cobble, or talus sparse vegetation (VII.B.)
PHYSIOGNOMIC GROUP	Sparsely vegetated rock flats (VII.B.2.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural Sparsely vegetated rock flats (VII.B.2.N.)
FORMATION	Boulder fields (VII.B.2.N.a)
ALLIANCE	AA Lava Bed Sparsely Vegetated Alliance

CLASSIFICATION CONFIDENCE LEVEL Weak

USFS WETLAND SYSTEM Upland

RANGE
Sunset Crater Volcano National Monument
Ponderosa pine – (Quaking Aspen) / Apache Plume – (Ocean Spray Scree) Lava Bed Sparse Vegetation occurs as islands of vegetation within the fractured black lava flow surface and at the edges of lava flow. This association is found within Sunset Crater Volcano NM on the jumbled and jagged aa lava beds mainly in the western portion of the park. In the project environs this association is also found on the lava beds that extend adjacent to the western park boundary and in a small section south of the park boundary.

ENVIRONMENTAL DESCRIPTION
Sunset Crater Volcano National Monument
Ponderosa pine – (Quaking Aspen) / Apache Plume – (Ocean Spray Scree) Lava Bed Sparse Vegetation's elevation is fairly constant and ranges from 2,100-2,130m (average 2,115m). The slope ranges from 0-15% slope (average 3%). The substrate consists of large soil pockets within aa lava and at the edge of the lava beds.

MOST ABUNDANT SPECIES
Sunset Crater Volcano National Monument

Stratum	Species
Tree canopy	*Pinus ponderosa, Populus tremuloides*
Shrub	*Fallugia paradoxa, Holodiscus dumosus*

ASSOCIATED SPECIES
Sunset Crater Volcano National Monument
Bouteloua gracilis, Ericameria nauseosa, Pericome caudata, Muhlenbergia montana, Ribes cereum

VEGETATION DESCRIPTION
Sunset Crater Volcano National Monument
Ponderosa pine – (Quaking Aspen) / Apache Plume – (Ocean Spray Scree) Lava Bed Sparse Vegetation relevés had total vegetation cover ranging from 5-45% cover (average 18%) cover. Within the tree layer absolute cover ranged from sparse to abundant (0-30%, average 18%). Cover within the shrub layer was consistent and ranged from 4-6% (average 5%). Cover of the herbaceous layer was sparse and ranged from 1-5% (average 2%). Species richness ranged from 4-22 (average 12 species) within the five relevés sampled.

The tree layer consists of scattered individuals of *Pinus ponderosa* (average cover 7%) and *Populus tremuloides* (average cover 4%). The shrub layer consists of mainly *Fallugia paradoxa* (average cover 3%) and *Holodiscus dumosus* (average cover 1%). The herbaceous layer is sparse.

CONSERVATION RANK G?

DATABASE CODE CEGL002929

MAP CLASSES

The association Lava Bed Sparse Vegetation is mapped as Lava Bed Sparse Vegetation (Map Code 6). This association is mapped as small inclusions of vegetation within the lava beds of Sunset Crater Volcano NM and in a small area of the project environs. The total area of Lava Bed Sparse Vegetation mapped in Sunset Crater Volcano NM is 79 hectares within 50 polygons and in the park environs is 5 hectares within 8 polygons.

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